Historic, Archive Document

Do not assume content reflects current scientific knowledge, policies, or practices.

UNITED STATES
DEPARTMENT OF AGRICULTURE
LIBRARY

BOOK NUMBER 1.6
So3S
v.3
July 1937-
June 1938
526641

GPO 8—7671

SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE · WASHINGTON

1.6
So 35
Cop 1

U. S. F. S. RECEIVED
LIBRARY
JUL 21 1937

9

630542
Agr.
68-76

USDA
LIB

JULY

Beginning Volume Three

1937

Contents

Page

Sand Rivers of China:
By W. C. Lowdermilk 1

Maintaining English Soils in "Good Heart":
By J. Everard Hosking 5

Fifty Years' Experience Gives Japan Simple, Effective Program:
By B. S. Detwiler 9

Sybaris: an Example of Watershed Control in Operation:
By Arthur C. Ringland 11

The Punjab Plans a Coordinated Attack:
By Guy R. Stewart 14

South African Problems Parallel Those of Great Plains:
By Lois Olson 18

Slowing the Raindrops in Java and Sumatra:
By Guy R. Stewart 22

Book Reviews and Abstracts:
By Phoebe O'Neall Faris 28

For Reference:
Compiled by Mrs. Etta G. Rogers ..... Opposite 28

Soil Conservation is issued monthly by Soil Conservation Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. Soil Conservation seeks to supply to workers and cooperators of the Department of Agriculture engaged in soil conservation activities, information of especial help to them in the performance of their duties, and is issued to them free by law. Others may obtain copies from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of $1.00 per year, domestic; $1.40 per year, foreign. Postage stamps will not be accepted in payment.

WELLINGTON BRINK
EDITOR

526641

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

H. H. BENNETT
Chief, Soil Conservation Service

VOL. III • NO. 1 JULY • 1937

ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON

SAND RIVERS OF CHINA

By W. C. Lowdermilk[1]

The Hwai watershed covers an area of 52,000 square miles. Its topography is unusual, for there is practically no divide on the north between this watershed and the delta plain of the Yellow River. Several times since 132 B. C. the Yellow River waters have broken the dikes and have spread over the land at the headquarters of northern Hwai tributaries and have usurped their channels. The most notable instance was the usurpation of the Hwai outlet to the ocean by the Yellow River throughout the entire 563 years, from 1289 to 1852 A. D. There must also be included in the northern portion of the Hwai Basin the bare mountainous area in southeastern Shantung drained by the twin rivers, the Yi and Hsu. Formerly these rivers flowed into the Hwai, but the deposition of silt by the Yellow River so elevated the outlet that they were forced to seek new outlets to the north of the original mouth of the Hwai. Thus, to the north the Hwai watershed except in Shantung is a great plain, with a very slight gradient and coalescing with the delta plain of the Yellow River.

To the south and west, however, the land area which drains into the Hwai is essentially mountainous. The Tsing Ling Range of Shensi makes a great bow or crescent; from western Honan, swings southward, then eastward. The eastern point of the crescent terminates in low, partially buried hills near the southern shores of Hung Tse Lake in northern Kiangsu. These mountains are composed chiefly of old igneous rock formations, and granite plays an important part and influences the erosion problems of the vast area.

An example of the temple (grave) forest and of the primeval forest cover. Dense growth of native oaks and shrubs.

[1] Associate Chief, Soil Conservation Service, Washington D. C., formerly Research Professor of Forestry, University of Nanking, China.

To the east the Hwai River finds itself blocked by the extensive silt deposits of the Yellow River which causes confusion in discharge of its waters, partly through the grand canal and partly through lowland lakes into the Yangtse River.

Temple Forests

To envisage what has taken place in the extensive mountainous region to the south of the Hwai River, mountains which doubtless contribute the major quantities of water for the Hwai floods, it is necessary to contemplate the primeval condition of the land surface. It implies a consideration of the type and extent of the cover of vegetation which the first human occupants of the region found. Fortunately, samples of this former vegetation are preserved in the temple forests, which the Buddhist priests, particularly, have jealously and religiously protected from annihilation. Likewise, graves of important personages, and of clans, have been so protected as to preserve exemplary growths of the native tree and shrub species. The forest of the ancient temple of Shui Ging An, at the headwaters of the Pi Ho, a tributary of the Hwai, may serve as a specimen of the primeval growth which long ago covered the mountain slopes of a vast region. Here are found the *Liquidambar formosana* and the oak as dominant species. The Liquidambar trees exhibit excellent development, reaching dimensions of 54 inches in diameter and a height of 125 feet. Oaks, likewise, reach splendid proportions. Bamboo played an important part in the vegetation, and doubtless in the primeval conditions it competed for place with the arboreal vegetations. Secondary species found in the temple forests are Tung Oil tree, *Aleurites* sp., *Celtis* sp., *Acer* sp., *Cunninghamia lanceolata*, and *Pinus massoniana*. The shrub and low growth is rich in species and densely covers the ground. In open spaces a very coarse vigorous grass, *Miscanthus sinensis*, Anders, first takes possession of the ground. It forms a dense and complete covering, but gives way to forest growth when in the course of time it is shaded out by overtopping vegetation.

Conquest of the Forests

Thus, the first human inhabitants who penetrated the region south of the Hwai River doubtless were confronted with a dense, dark, and terrifying wilderness of forests which harbored ferocious animals. The conquest began and has proceeded through many centuries. Today practically no part except a few of the relatively small areas of temple forests has escaped the agricultural conquest of human inhabitants. Either

The Hu River and its bridge, at Kwangchow. It is said that 70 years ago the sailing junks of the Hwai moored here regularly and that the place resembled the port of Peng Pu. Now no sailing boat can reach Kwangchow owing to the sand-filled condition of the river channel.

the original cover has been cut, burned or destroyed and the subsequent growth subjected to some method of treatment, or the underlying soils have been entirely cleared or cultivated. Today, on these sloping lands, bared of their forests, the cultivation of corn and wheat, tea, and China root crops goes on.

The progressive baring of the mountain lands has produced a corresponding progressive change in flood

An effective device used in Anhwei to divert the current of a mountain torrent.

plain deposits from the blackish blue clays to brown and yellow superimposed silt and sandy silts found along the rivers, and finally is chiefly responsible for the rivers of sand which have been set in motion and are working their way northward down the tributaries and eastward down the Hwai River proper. The sand has reached Wu Lung Chi on the Hwai, and has reached the Hwai at Cheng Yang Kwan from the Pi Ho.

These sand rivers are believed to derive the vast quantities of sand partly from the general sorted deposit from the erosion of the mountainous areas of igneous rocks in recent geologic time, and partly from the accelerated erosion following the general

Pine trees alone do not necessarily prevent erosion of the upper soil layers.

baring of the slopes through cultivation within the past millenium and more particularly in the past five centuries. Evidence points to a marked acceleration in these processes during the past century.

A view of the landscape to the east of the Ma Pu, showing the state of slope cultivation, chiefly of tea.

These rivers of sand fill the channel of the Hwai and its tributaries, causing local overflowing of flood waters, and in their downstream movement will in time progressively jeopardize the permanency of costly engi-

neering works in the lower Hwai. Particularly will the sand, unless controlled, interfere in time with navigation and with the ample discharge of flood waters to the sea.

Near Ma Pu, a thriving little city in the Pi Ho Basin, the quantity of sand in the river valleys is inexplicably great. The valleys are wide stretches of sand with abrupt banks of igneous and metamorphic rock. The width of the valleys is remarkably out of proportion to the drainage area for a moist climate. The valleys are wide; they present the appearance of old arid valleys filled with sand. The little isolated igneous rock mountain surmounted by a temple, called Tu Shan, which lies 30 li up the stream from Lian Ho Ko, rises as an island out of a sea of sand. It is 150 feet high and lies surrounded by a sand plain 1½ miles wide. In this plain where flood waters can be diked off the sand has been built up and reclaimed first with the planting of willows. In time sufficient humus is produced to make cultivation of crops, with fertilization, possible. The sand therefore where not annually inundated is reclaimed and used for farming.

Tea Culture

The topography of the region about Ma Pu is picturesque. It is characterized by deep steep-walled, incised valleys, and high irregular mountainous sky lines. Only a small fraction of the landscape lies as level land in the narrow alluvial plains of the streams. The slopes are accordingly cultivated to yield first the tea, whose special quality has brought renown and profit to this section, and then the field crops for food supplies.

The culture of tea has become destructive to the slope soils. No attempt is made at terracing the slopes. The only measure employed throughout the entire area to prevent excessive gullying is the cutting of slanting ditches along the slope, 10 to 30 feet apart, to lead surface run-off to side drainage of the fields. This device prevents temporarily the formation of gullies down slope through the tea plantations.

Erosion goes on apace, and the soils are thinned down by the annual waste until the slopes become unproductive. The loss of soil due both to soil creep from plowing and from wash is excessive. In the culture of tea it is the practice to keep the ground about the tea bushes bare of other vegetation, which on steep slopes causes rapid erosion. Likewise, the life of a tea field is limited to 30 years, this being due to the gradual and continual loss of soil through soil wash. Bench terracing, certainly, becomes the only allowable measure to provide for a sustained production of food crops and tea on sloping land.

In the southern Honan region of the Hwai watershed the culture of China root has brought about conditions which have accelerated the wash of soils from the granite mountain area. It is the practice to cut off the pine forest, to remove all vegetation and all root stocks from the plot to be devoted to the growth of China root. Then billets of pine 4 feet long and up to 4 inches in diameter are buried first under the surface of the sandy soil with only one set of ends visible. These ends are thereupon impregnated with the spores of the fungus. If the growers are fortunate enough to secure a "catch" of the fungus, the mycelia run through the wood and then send forth a fruiting body downward into the loose soil. The fruiting body has the appearance of a root, being blackish on the exterior, hence the name China root. The interior of the fruiting body is pure white, compact, and possesses the consistency of cheese. This is the product which has a high value and has achieved sufficient importance to make up a significant part in the customs trade.

It is the practice to grow only one crop in one plot each 20 years, since it is believed that a second crop will not grow satisfactorily. The tendency has been to clear the mountains progressively; to rob the soils of all reinforcing elements, and to expose them to serious erosion. So general was the cultivation of China root a few years ago that the erosion and resulting torrential flows had become of such serious proportions as to arouse the local inhabitants to its gravity. Within the past 20 years the local inhabitants have reduced the cultivation of China root, and at Shih Lian Tze, the center of the culture area, there is a saying "Cheated by the China root" and this would indicate that the growers themselves realize fully that the damage to the country through China root cultivation greatly overbalances the benefits from the product.

In China, truths which become generally recognized are frequently, if not usually, reduced to proverbs. The following local proverb will indicate something of the attitude of the aggregate mind of the region toward the problems of erosion.

> When mountain vegetation is devoured by iron cattle,
> When the sand bars have reached Chen Yang Kwan,
> The prosperity of Hwo Shan (Hsien) will end.

Iron cattle here are said to refer to the iron mattocks of the farmers who cultivate the mountains, especially for tea. The significance of the sand bar is the interference with navigation.

(*Continued on p. 26*)

MAINTAINING ENGLISH SOILS in "GOOD HEART"

by J. Everard Hosking N.D.A – F.L.S[1]

DURING a recent visit to Washington, D. C., I was honored by the Editor of Soil Conservation when he asked me to write an article for this issue. As one who regards the study and care of the soil as being fundamentally important to the welfare of mankind, I am pleased to have the opportunity of contributing something to emphasise the importance of a subject that has been neglected for many years in practice, if not in theory. The neglect is not confined to one land, nor are the consequences entirely confined to one people. Peoples recognise frontiers but soil has no such limitations. Soil wealth, the accumulation of generations, has been raided in many parts of the world

[1] The author holds the National Diploma in Agriculture (practice and science) and is a Fellow of the Linnean Society of London. He is a graduate of an agricultural college and a director in an intensively farmed estate of nearly 2,000 acres.

Fifteen sheep and lambs are maintained on this pasture of Kentish wild white clover and ryegrass, from April to October.

THE EYE OF THE MASTER

WITH proper allowance for the differences between the English and the American types of agriculture, Mr. Hosking's article is arresting and stimulative in the emphasis it throws on certain more or less neglected aspects of soil husbandry. It reminds us that "The eye of the master fattens the cattle"—that every single piece of soil must be studied and understood if it is to be retained and used to the best advantage.

There is no question that fertile soils and newly broken sod can be worked much sooner after rains than poor and overexploited soils in which there remains little organic material. It has been noted that heavily fertilized garden soils lend themselves to intensive cultivation more readily than fundamentally similar soils under field conditions. Newly broken swampland in northwestern Ohio responded readily to tile drainage so long as it was freighted with organic matter; once depleted, however, not even twice as many tile availed to keep the soil in condition to work. A recent report of the Missouri Agricultural Experiment Station, Bulletin 369, refers to the production of manure artificially in England, and makes interesting reading in connection with Mr. Hosking's contribution.

A large amount of erosion in the United States is a result of the demand for grain or concentrates for livestock feeding. Now it is possible, as set forth in Vermont Agricultural Experiment Station Bulletin 350, to obtain artificially dried grasses, cut at immature stages, which have many of the qualities of concentrates and offer an acceptable substitute for the feeding of most livestock. Even hogs will consume considerable quantities of such grasses, as shown by their eating of alfalfa hay. As more economical methods of drying are developed and the costs of soil losses become more apparent, it is possible that more extensive use will be made of perennial grasses and legumes in lieu of cultivated crops when there is a conservation advantage to be gained thereby. Such substitutes, properly handled, can be converted into ensilage. As pointed out in Research Bulletin 62 of the Nebraska Agricultural Experiment Station, feed so produced carries high vitamin values which help to produce winter milk comparable to milk produced from fresh green pastures.

—THE EDITOR.

Steep slopes slightly terraced for cattle and sheep grazing. Terraces accentuated by livestock use. Soil light sandy loam over chalk.

until a state of dusty desolation is reached. What was living and productive of more living things has been bled of its life and remains to add to the modern problems concerned with the disposal and utilisation of the derelict and waste. Exploitation has been, perhaps, greatest on the richest virgin soils where acres have been plentiful and cultivators comparatively few; the art rather than the science, of good husbandry has not been understood, or if understood, not regarded. I believe that there is more danger

Young cattle on young pasture of wild white clover and grasses. Chalk hill in background grazed close by sheep to maintain vigorous herbage. If neglected, bare patches occur and land becomes barren.

today of losing the art of soil cultivation than of being ignorant of soil science. Frequently, the art of a skilled cultivator dies with him whereas the facts of science are preserved in records.

The cultivator who possesses the art of good cultivation together with a knowledge of the facts demonstrated by soil scientists is the real soil builder. He recognises the fertile soil as a living complex and not an inert mass; the boundary between death or decay of one generation of plants in the soil and the life of another springing out of it, is very narrow. He strives to maintain and, if possible, to increase the vitality of the soil of which he has charge. These soil builders can usually be found in greatest numbers in localities where land is scarce in proportion to the population

Tethered sows with litters are moved systematically over the land.

it has to feed, and the art of cultivation is passed on as a necessity from one generation to the next. Since the Great War, in years with huge surpluses of food commodities and resulting uneconomic prices, cultivators in many lands have been forced to break the rules of good husbandry by producing crops out of the normal rotation from which they hoped to retrieve, at least, their costs of production. The fact that the bad effects of this misuse of the soil were not apparent for some years led them to continue the practice until today there are soil deficiency problems in districts where the exercise of good husbandry in the past had maintained and improved the standard of fertility. The deficiencies encountered in recent years are many and the results may be seen in the crops and on the

livestock fed on those crops—to say nothing of the other major effect, erosion.

The fact that the health of all living things is closely related to the health or vitality of the soil is not common knowledge, and there will be little chance of arousing much general enthusiasm for the care of the land until this truth is widely accepted. The subject shows signs of receiving more attention in different lands and it is very heartening to learn of the progressive work already done in the United States. In the British Isles, although soil deficiency is not yet a serious problem, there are such diseases as heart rot in swedes, milk fever in cows, and pining in sheep (similar to coastal disease of sheep in New Zealand—a mineral deficiency disease)—to name a few—definitely attributable to mineral deficiency in the soil and crops. These are all remediable by adding the necessary minerals to the soil. I have witnessed remarkable results from the addition of comparatively small quantities of certain minerals such as iron and calcium to the soil. The plant would appear to be the best medium through which the herbivorous animal can derive its mineral requirements.

A steep terraced slope.

Soil scientists have yet much to do before this complex subject can be reduced to an exact and workable science. They have already accomplished a great deal, which knowledge is being put to good use by the intelligent cultivator. In our present problems of soil building and rebuilding, we have much to help us from (1) scientific contributions and (2) the experience of successful cultivators of the past. In England, prior to the Great War, land was maintained in what is called "good heart" by the successful cooperation of livestock and the plough. The old Norfolk rotation (roots, barley, clover, wheat) formed the basis of good arable farming. It was varied to some extent but not to affect the principles of good husbandry underlying it. From the point where that system was first introduced can be traced a successful building up of soil fertility and improvement in livestock. I believe it is equally true to say today that there has been a steady decline in fertility since the period, during the war and post-war, where this system has been abandoned.

Ewes and lambs folded on kale. Plowed and followed by cereal crop.

Wild white clover protects this roadside slope.

The underlying principle of this system is still accepted by all good husbandmen as the basis of good farming for the maintenance of soil fertility and healthy livestock. The aim is to maintain and if possible to increase, the organic content of the soil, appreciating, too, the value of livestock secretions in promoting soil vitality. Here the earthworm flourishes and contributes its share to the soil well-being. One crop in the rotation, usually the root crop, was heavily manured by the muck from the livestock yards, or the root crop was eaten off "in situ" by the sheep on a careful system of control in hurdles—moving the hurdles to fresh ground each day. This method of eating off crops "in situ" by animals is called "folding" to which reference will be made again later.

The straw from the cereal crop was always used in the stockyards to be returned later to the soil as farmyard manure, a very sound practice. To hear is good, to see is better, but to operate is best. The practical farmer reared in this tradition appears to possess an instinct for appraising subtle, but important, qualities in his land and livestock. The skillful farmer, by organizing the right cooperation between the soil, crops, and livestock maintains the health of all three. Since the war many of the old and well-tried systems have been knocked "out of gear" in the interests of assumed economy and the dire effects have first shown themselves where there is least reserve of stored fertility, and a great number of the younger generation of cultivators have not inherited any, or sufficient, of their forefathers' skill to enable them to recapitalize their soils—the problem has been aggravated by the low prices ruling for beef cattle. Agriculture owes much to cheap artificial fertilisers, but these give their best returns from living earth where moisture, bacteria, organic matter, sun, and air can all play their part, for it is well to emphasise that a fertile soil is a living complex and needs a wide range of material to maintain its vitality, and the vitality of the animal kingdom that depends on it.

In seasons of drought I have been impressed by the fact that fertile soils suffer least. Possibly two of the most important reasons are that the more luxuriant plant population inhibits surface evaporation together with a better retention of soil moisture due to the generous root system and humus content. These soils also drain better in wet seasons, and serious erosion is unlikely to occur where the particles are so well knitted by myriads of roots. Good farmers in England have always utilised the clover family as the legumes to play a major part in maintaining soil fertility, as well as to provide nutritious food for livestock. The red, white, and alsike clovers and alfalfa in low rainfall districts are used in short leys first to provide a fodder hay crop and then to be ploughed under and followed by a cereal. Wild white clover, the seed of which was first produced on a commercial scale in the County of Kent, was used formerly only in permanent pasture mixtures, but it is now being used much more extensively in short ley mixtures as it is found to cooperate well with other grasses and clovers, and its elaborate rooting system enriches the soil with nitrogen and organic matter.

I will give a brief and general account of the practices most commonly adopted by good English farmers in keeping up the organic content of their soils.

(1) Arable farms with beef and/or dairy cattle

Farmyard manure is ploughed into the soil and if necessary catch crops such as mustard are ploughed in. Grassland with an abundance of wild white clover is grazed for one or more years and ploughed in.

(2) Cereal farms—with perhaps sugar beet—with no or few livestock

Green manuring is practised. The ploughing in of catch crops such as mustard, vetches and lupins, also a clover crop, first cut for hay and/or seeded and ploughed in.

(3) General or mixed farms

Farmyard manure from stock yards is ploughed in. Green crops such as kale, swedes, turnips, vetches are folded (system mentioned earlier) by sheep, moved to a fresh piece of ground each day, after which the land is ploughed. Grassland folded by sheep, or chicken (in small movable pens), and alternately by cattle, then ploughed. There is usually an abundance of wild white clover in addition to the grass in such pastures.

(4) Grass farms

Here open-field cattle and sheep grazing is common, as well as the controlled grazing system or folding. On many hill and light land farms movable mechanical milking bails are used for economy and to distribute the animal excreta more evenly. Chickens are moved in small pens, systematically, over the pastureland. Grass silage is made from some of the surplus young grass, and a quantity of hay. A more modern method

(*Continued on p. 13*)

FIFTY YEARS' EXPERIENCE *Gives Japan* Simple, Effective Program

by B·S·Detwiler[1]

During the past 50 years the national soil conservation program in Japan has proved its effectiveness in checking soil losses from erosion. Regulated tillage, intelligent farm management, reclamation practices, and care for the steeper lands have yielded quick and convincing results, and this fact undoubtedly lends encouragement to the newer program of the United States. Except that procedure in revegetation is relatively simple and standard, the control methods in Japan are similar to those with which we are familiar.

New light was thrown on Japan's plan when, not long ago, Mr. Kakuro Oshima, who is a member of the Forest Service, Department of Agriculture and Forestry, Tokyo, visited the Washington offices of the Service. Additional facts have been forthcoming through correspondence with Prof. S. Sakurai of the Department of Forestry, Faculty of Agriculture, Tokyo Imperial University. Professor Sakurai describes the general methods as follows:

[1] Head, Section of Hillculture, Soil Conservation Service, Washington, D. C.

A planting of Miscanthus sinensis *and lespedeza bicolor. (Photographs by S. Sakurai, Tokyo Imperial University.)*

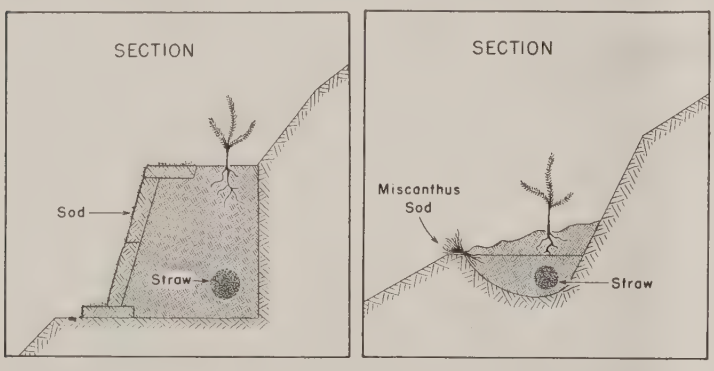
"In Japan eroded places are limited to mountain slopes where the mantles of vegetation have been destroyed by heavy rains or earthquakes. There is almost no soil erosion in fields because the fields are usually divided into many small areas.

"Now I will explain to you an example of erosion-control methods most commonly put in practice in Japan. In the torrential valley, dams and other constructions are made in order to prevent erosion by

Engineering structures that attest the earnestness of Japan in her program to check soil wastage.

Erosion control has reached a high state of development in Japan.

establishing a base level. On the mountain slope that is steep and has irregular features, soil is graded down to the tenable gradient under natural conditions. Small horizontal shelves or terraces are cut in the slope, usually 1 or 2 meter contours. On this shelf, slabs of grass sod are placed as a retaining wall as shown in the following figures:



"Behind the sods, soil is pulled down from the slope above and tamped in place to a depth of 0.3–0.4 M. and a width of 0.3–0.6 M. On this shelf pines and alders are planted alternately with a distance of 0.5 M. Fertilizers such as calcium superphosphate, ammonium sulphate, ash, and straw of rice are sometimes applied.

"When the slope is not steep and mantle of soil is deep, the slabs of grass sod are omitted as a retaining wall, but Miscanthus sods are set along the front edge of the shelf."

A principal feature of the Japanese system which the writer believes may be of considerable importance to the work in this country is that erosion-control plants have been reduced to a very few species having outstanding qualities and wide adaptability. This has made possible a high degree of economy, both as regards the production of planting stock and in the erosion-control planting operations.

Only a few species of shrubs, trees, and grasses are used in initial erosion-control work in Japan. They are all plants which grow well on practically any soil or site, are readily planted, fast in growth, and cheaply grown as nursery stock. In particular, their root systems ramify so as to anchor the soil. The products of these erosion-control plantings are sometimes used for fuel or forage, but the Japanese consider that the primary function of erosion-control plants is to stop quickly the washing of the soil. If they serve this purpose well, their other values are of minor importance.

The species of trees and shrubs used are as follows:

1. *Pinus densiflora*, Sieb. and Zucc.
2. *Pinus thunbergii*, Parl.
3. *Alnus firma*, Sieb. and Zucc. var. *Sieboldiana*, Winkl.
4. *Alnus firma*, Sieb. and Zucc. var. *multinerva*, Regel.
5. *Alnus tinctoria*, Sarg. var. *glabra*, Call.
6. *Robinia pseudoacacia*, L.
7. *Lespedeza bicolor*, Turcz, var. *Japonica*, Nakai.

The second and fourth plants in this list are the ones most commonly used. Nursery grown seedlings, 1 or 2 years old and 8 to 12 inches tall, are planted. Any grasses growing naturally on the hillsides and having ability to stabilize the ground surface rapidly are considered valuable, but *Miscanthus sinensis*, Andress, is most suitable.

Robinia pseudoacacia is still used for erosion control, but, because of its shallow-rootedness it has shown poor results when planted on steep hillsides where the soil is not deep or where wind attack is severe. The wood of this species is used mainly for fuel; other uses of it are being tested. Its leaves are used for forage and green manure. The abundant spring growth after the trees are cut down interferes with the growth of the coniferous trees desired to replace the locust, so that this species is not so widely used in erosion planting as formerly.

Erosion control has now reached the high stage of development in Japan where the only serious erosion problems are on steep, nonagricultural lands. These lands are being reclaimed and maintained for the production of forests, chiefly soft woods (pine and cedar). It was emphasized by Mr. Oshima that in carrying out the dual objectives of erosion control and forestry on erosive lands, they had found it most effective to manage and conduct these operations separately on the basis of their clearly designed purposes. Accordingly, the reclamation and stabilization of the soil which embraces both the engineering and vegetative phases of erosion prevention and control is planned and directed by the soil conservation experts with the uncompromised aim of speedily qualifying the eroded areas for productive use. When this has been accomplished, the land is turned over to the land-use agency responsible for crop development and proper management of the reclaimed land. The outstanding success of this feature of the Japanese plan recommends it for our consideration.

COMING ARTICLES

No single issue of this magazine can attempt to give a world picture of soil conservation activities. Much valuable material on conditions and programs in other lands is in the editorial basket and will be presented in future issues as space will permit.

Sybaris: An Example of Watershed Control in Operation

By Arthur C. Ringland[1]

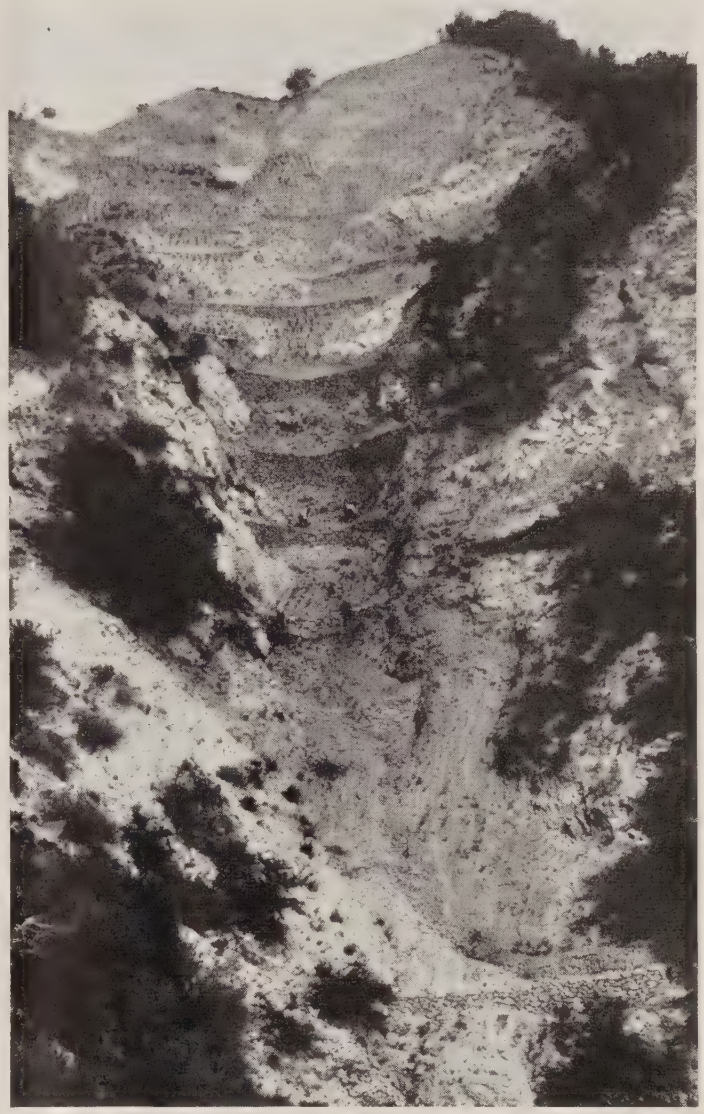
In the May number the general policies and principles underlying the Italian national land plan, or "Bonifica Integrale", were outlined. It was emphasized that a watershed becomes not only a project for flood control but a unit of land planning and administration within which all resources are developed to serve their highest usefulness. The Sybaris project in Calabria is an excellent example of projects which I inspected in Italy.

Hellenic settlers founded Sybaris in 700 B. C. It became the most opulent of the Greek cities and its citizens were known for the splendor and luxury of their living. And so "sybarite" became for all time the synonym for a luxurious person. For years Sybaris flourished, eventually to be wasted by war and eliminated by pestilence and floods.

Marshes Created by Slope Erosion

It is not possible to establish chronologically the manner in which the Sybaris area reached its present state of abandonment. There is little doubt, however, that the progressive erosion of the slopes of the surrounding mountains was one of the principal causes. These mountains, largely deforested, and subjected to unremitting pasturage, almost everywhere show damage accelerated by the geological character of the soil and the steep nature of the terrain. Thus, after every rainfall, even though brief, the meager works of protection attempted in the past were seriously menaced and often completely carried away. The flood waters inundated the lowlands, creating marshes and only through slow seepage reached the sea. Until the present project was undertaken a conception of the problem as a whole was lacking and there was no attempt to impose a complete solution in its two-fold aspect of sistemazione dei bacini montani—regulation of the mountain watersheds, and of bonifica della pianura—reclamation of the plains.

The Sybaris project includes a natural economic unit embracing the tributary watersheds of the Crati River between the slopes of Mount Pollino and the Sila Greca Hills and the Gulf of Taranto. The work may be divided into four phases—the conservation works in the mountain watersheds, the reclamation work of the plains, the improvement works for intensive cultivation and settlement, and finally the work of malarial control. These works in accordance with the cardinal principles of Bonifica Integrale are undertaken as a unit operation.



The denuded slopes are planted to American locust, a feature of the control work on the watershed of the Torrent of Grammasati, Calabria.

The total area—compresorio—of the project to be conserved and reclaimed is divided into the mountain and hilly area of 347,443 acres, and the plains of 79,099 acres, a total of 426,542 acres in all.

For the purpose of conservation the mountain area is divided into three sections averaging in altitude from

[1] Chairman, Flood Control Coordinating Committee, U. S. Department of Agriculture, Washington, D. C.

2,300 to 3,300 feet and ranging to a maximum of 6,600 feet, and is clearly defined by hydrogeological characteristics, extent of deforestation, and exploitation for cultivation or pasturage by sheep and goats. Two of the sections, the northern and the southern, where calcareous and clay soils predominate, and where exploitation has been intensive, show in most of the watersheds a general and menacing condition of erosion. Conditions are less threatening in the centra section where the streams are constant and carry down only fine material in suspension.

Stream-Bank Sliding

The mountain streams present three phases characteristic of this part of southern Italy. Ordinarily the stream beds, temporarily choked with debris, are dry throughout the greater part of their length with only a slight trickle of water in the upper reaches. During the rainy season from November to March, however, a small vein of turbid water begins to creep on the surface of the streambeds. In the second phase the streams flow tranquilly with but a slow erosion of the beds. It is the third phase, much more brief than the two preceding, that presents catastrophic characteristics. A sudden rainfall, of even moderate intensity, taking place during the rainy season when the denuded soils are already replete with moisture, provokes the sliding of entire slopes. Enormous quantities of solid matter are carried toward the plains in a few minutes and the streams become rivers of mud thick enough to hold masses of rock in suspension. These masses, aggravated and augmented by the material brought in from the tributaries and confined between steep banks, carry along all obstacles encountered until they debouch on the plain.

The annual precipitation of the Sybaris region averages 48 inches, of which 40 inches fall between November and March. The period from May to October is one of prolonged drought. The east winds charged with moisture from the Ionian Sea cause the heaviest precipitation when they encounter the high barriers of the Pollino and Sila ranges. The other winds are comparatively dry. Observations of the Royal Hydrographic Office have been carried on since 1915, and within that period a precipitation of more than 7 inches in 24 hours has been noted. There is reason to suppose that the fall is even greater at times, for experience has demonstrated that the regulation of mountain watersheds must be of an extensive as well as an intensive character to be effective.

The plan of conservation works therefore includes the complete reforestation of the denuded lands of the high basins; fixation of the slopes exposed to landslides by means of grading, terracing, and consolidation with lattices and fascines, followed by successive sowings and plantings of grasses and trees to strengthen and bind the soil; prohibition of pasturage in all localities where such works are located and its regulation elsewhere; the prohibition of further agricultural exploitation in the high basins and on steep slopes; and the regeneration of deteriorated forests.

The intensive work consists of the construction of masonry dams of small dimensions at the foot of landslides, along the larger stream branches, and larger dams where it is possible to obtain holding areas for the deposit of soil carried down from the slopes. The flanks of the streams are also protected from gouging by networks of large stones. The intensive and extensive work now planned will necessitate the reforestation of 25,000 acres, the regeneration of 57,000 acres of deteriorated forests, the fixation of 2,500 acres of landslides, the construction of 950 dams for stream flow correction and control, and the building of 30 miles of trails.

The Sybaris plains are divided into two parts by the Crati River. This river is fed by a network of streams which often change their courses owing to the huge amounts of debris they bring down from the mountains. The clays which are found everywhere in the hilly and mountainous parts of the watersheds have been deposited on the plains during the winter floods, forming an impermeable bottom. As a consequence, thousands of acres of fertile soil have become permanent marshland and breeding places for the anaopheles mosquito.

To Control Waters

The most important problem of the Sybaris plains is the diversion of the waters. By building embankments along 62 miles of the lower courses it is planned to confine the "external water" from the mountain watersheds to their natural channels. The "high" or flood waters from the hills and lower mountain slopes are to be gathered into special channels and directed into the natural river courses; and, finally, the "low" waters of the plain itself are to be drained by a network of canals and ditches and discharged into the sea. This canalization involves 155 miles of construction.

The problem is a difficult one because of the enormous quantities of solid materials carried down to the

plains by the numerous streams and the River Crati. The necessity of curing the disease at its source through the "sistemazione" of the mountains is at once apparent. Normally it is considered that such work is a preliminary condition to undertaking the reclamation of the plains. In the Sybaris project, however, it was advisable to carry on simultaneously the conservation work in the mountain watersheds and the regulation of the water courses of the plains.

The improvement works consist of the construction of arterial highways supplemented by a network of secondary roads totaling 120 miles to afford an adequate transportation system connecting with the railhead at the new village of Sybaris. This village is one of eight model rural centers, each housing 500 inhabitants and designed originally to accommodate the workers on the project but later used as homes for the settlers. The improvement works also include a domestic water supply for the villages and an irrigation system adequate for the intensive cultivation of 17,290 acres. Finally, to eliminate as far as possible the danger of malarial infection all borrow pits excavated in the course of construction work and all depressions holding stagnant water will be drained and the American minnow propagated to feed on the mosquito larvae.

At the time of the inspection the Sybaris project had been under way for 4 years. It will take 10 years in all for completion. The work was started in 1928, and since that time about 25,000 acres or a third of the plain has been reclaimed, 3 model villages built, 30 miles of road constructed, and 4 of the 12 important mountain watersheds "systematized," employing a daily average of 1,500 workers and at times 4,000.

Financing Conservation

The entire project upon completion is estimated to cost $12,500,000, shared largely by the State and by the consortium of interested landowners. Such associations are generally organized for each of the important projects. Membership is compulsory if the owners representing the greater part of the area organize a consortium and under certain conditions even if but one-fourth of the land is represented. These associations have the legal character of public-utility corporations with the right to issue obligations and bonds, contract loans, and to levy upon the members for their individual share of the costs of the project. The contributions of the members are taxes upon the property of the contributor, and they are classified immediately after the land tax and the respective provincial and communal surtaxes.

The conservation work in the mountain watersheds and the flood-control measures necessary for the principal watercourses on the plains, particularly the Crati River, are carried out at the expense of the State. The State contributes to the costs of the other types of work. In southern Italy where land development is particularly difficult the State's share is 88 to 92 percent of the cost of the principal reclamation works; 75 percent of the cost of building rural aqueducts for the main supply of potable water; 45 percent of the cost of installing rural electric power stations and from one-third to 38 percent of the cost of the erection of rural villages, building and improvement of farm roads, provision for local water supply, drainage, and irrigation.

Maintaining English Soils

(*Continued from p. 8*)

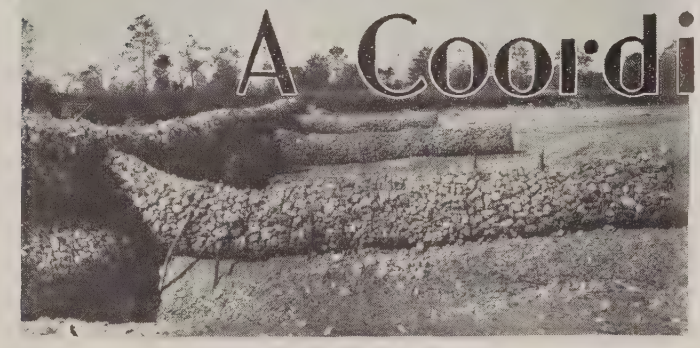
Chicken folding huts are moved systematically over the land.

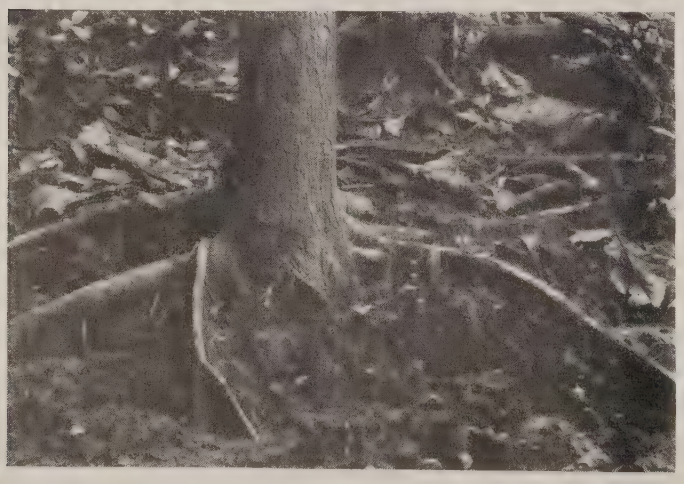
of utilising young grass and clover for cattle food is to dry them in mechanical driers—a growing practice.

Where folding is practised, it is usual to supplement the grass or green food by some concentrate. When a rich pasture is being folded, and the grass and clover are young and therefore rich in protein, it is customary to supplement by a carbohydrate food such as corn. If the crop is more advanced in growth a protein supplement may be necessary. The residue from these supplementary foods adds to the fertility of the land. A newer practice to be highly recommended as a means of adding organic matter and a large quantity of nitrogen to the soil, particularly after sheep grazing or mowing a pasture rich in true wild white clover where the grazing and / or mowing encourages a mass of stolons as well as roots, is to sow 200–400 pounds per acre of calcium cyanamide over the crop, disc and cross disc (disc harrow) to chop up the mass, and plough into the soil. The land is then in good heart for succeeding crops. In all the systems outlined

(*Continued on p. 28*)

The PUNJAB PLANS
A Coordinated Attack





by Guy·R·Stewart[1]

SOUTHERN and central India consists largely of rolling hills and valleys without high elevations and is separated from the northern ranges by the wide plains of the Ganges and the Punjab.[2] Beyond these plains the Himalayas rise with steadily increasing elevations that mark the division between India and the high plateau of Tibet.

The climate of India shows wide variations, being largely subtropical in the plains, with intense summer heat, but with moderate temperatures in the higher hills. With increasing elevations in the Himalayas there is a relatively short summer season and an appreciable winter snowfall which later melts and passes down into the streams of lower valleys. The rainfall likewise shows a wide range of variation, from practically desert conditions in Rajputana to high rainfall reaching well over 100 inches of precipitation in the Himalayas. Approximately half the annual rainfall in most localities falls during July, August, and Sep-

---

[1] Assistant to the Chief, Division of Research, Soil Conservation Service, Washington, D. C.

[2] This discussion of erosion conditions in India is based on material furnished by the following:

Glover, H. M., and Hamilton, A. P. F. Soil Erosion and Allied Problems. 4th British Empire Forestry Conference, South Africa, 1935. pp. 1–7.

Hamilton, A. P. F. Siwalik Erosion. Indian Forester, vol. LXII. 1936. pp. 375–387.

Gorrie, R. M. Notes on Soil Erosion in the Punjab. Manuscript communication. Indian Forest Service.

Sah, D. L. Note on the Afforestation of Jumna, Chambal, and other ravines. Manuscript communication. Indian Forest Service.

The accompanying illustrations are used through the courtesy of the Indian Forest Service.

THE PICTURES—Top to bottom

Sausage bund on Raidak River, Bengal. (Photograph by R. S. Troup.)

Famine laborers making ridges and ditches on a steep slope. Reclamation of ravine land. (Photograph by E. A. Smythies.)

Area unplanted and heavily grazed. Public forest, Shahpur division, Punjab. (Photograph by Fazaluddin.)

Pure plantation (1916) of Tectara grandis, *showing erosion due to absence of undergrowth and to burning. Upper Burma. (Photograph by H. G. Champion.)*

THE PICTURES—Beginning at top

Eroded slopes in the outer Himalayas. The erosion has been increased by grazing and cultivation. (Photograph by M. V. Laurie.)

The Sal jungle in Bengal is receding gradually and erosion has started, but on this rocky soil it is making slow headway. (Photograph by J. C. Nath.)

Afforestation in typical ravine country. (Photograph by E. A. Smythies.)

Afforestation has been under way four years on this ravine land. (Photograph by E. A. Smythies.)

Here is what ensues from heavy grazing. (Photograph by E. A. Smythies.)

tember, in what is known as the summer monsoon. April and May are generally dry and intensely hot. The autumn period is dry but cooler and in winter, in most places, there is relatively little rainfall. In northwestern India, the annual rainfall is lower and the valley of the Punjab, formerly considered a desert, has been irrigated by water drawn from the permanent streams of the Himalayas.

The Sacred Cow

Glover and Hamilton have pointed out as one of the most important factors affecting plant cover throughout India the fact that the Hindu population considers the cow as a sacred animal which must be preserved even though it becomes old and relatively useless. In consequence of this, nearly every village has herds of cattle which are often far more numerous than the villagers require. These herds frequently increase to the point where the district is unable to supply adequate forage for their nourishment. With the heavy Indian population there is little land available for pasturage and no regular meadows are ordinarily set aside for livestock. The cattle consequently graze on waste areas or in the edges of the forest, being driven up from

the villages by small boys or herders. In most cases, the cows are poorly fed and undersized. It is only in a few of the alluvial, irrigated plains that the stock is regularly fed in stables.

Teeming Population Reduces Cover

Throughout all the cultivated areas of India the population is extremely dense, even running as high as 1,500 people per square mile in the river plain of the Ganges. In consequence, the land holdings are small, often approximating only 3 to 5 acres for a cultivator. When a land holder dies, it is customary to divide his small farm among his sons, with the result that the subdivision of land is smaller than that of any of the countries in Europe.

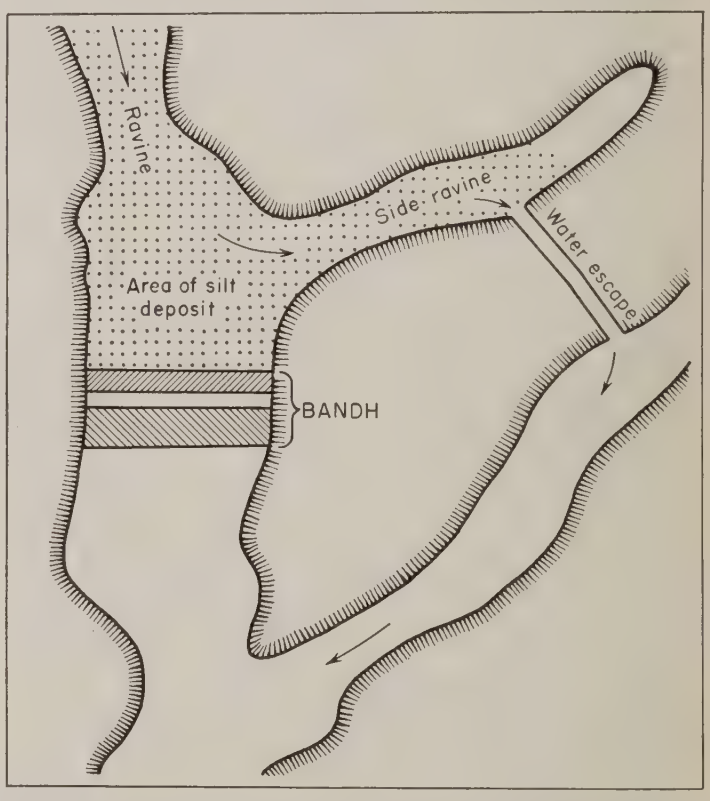
In addition to cattle, goats are kept in every village and are turned out to graze on herbage and small bushes from which the cattle have not been able to get any nourishment. In the mountains of the Himalayas there are large migratory bands of sheep and goats which are driven into the high pastures in the summer and in winter are moved down to utilize the vegetation on the already overgrazed foothills. In the lower foothills of the Himalayas, nomadic grazers have kept many herds of buffalo. With the demand for forage, all of the palatable, broadleaved trees are cut by the natives where they can reach the branches, and this again has tended to reduce the plant cover.

Himalayan Foothills Eroded

In a survey of erosion conditions made at the first meeting of the Crops and Soil Wing of the Board of Agriculture and Animal Husbandry in India, in 1935, it was pointed out that erosion was especially acute in parts of Madras, the Bombay Deccan, the outer Provinces, the Punjab, the central Provinces, Chhota Nagpur, and central India. Gorrie has stated that the most serious erosion is confined to the great belt of foothills and sloping ground extending for 1,600 miles along the main ranges of the Himalayas. This area reaches from the Siwaliks and the outlying rocky hills typical of Gurgaon in the east to the salt range in the west. The area involved is approximately 35,000 square miles, extending in a strip some 60 miles to 120 miles broad across this portion of India.

Silting Evidence of Erosion

Even outside of the acutely eroded area the effects of soil erosion have been evident in the silting of irrigation supplies resulting in the partial filling in of reservoirs and the clogging of irrigation ditches, to say nothing of the difficulty which has been caused by this sediment in operating many of the hydroelectric plants. For example, the heavy load of silt derived from the Jammu and Gujrat foothills carried by the Jhelum River has decreased the carrying capacity of the upper Jhelum canal by 40 percent, even after the expensive installation of a number of silt ejectors.



Gorrie lists as the chief causes of erosion, (1) poor cultivation of unterraced or poorly terraced land with the undue extension of potato cultivation; (2) ab-

normally heavy grazing of home and migrant flocks in the vicinity of villages; (3) seasonal concentration of migrant flocks along the travel routes leading to the alpine meadows of the Himalayas.

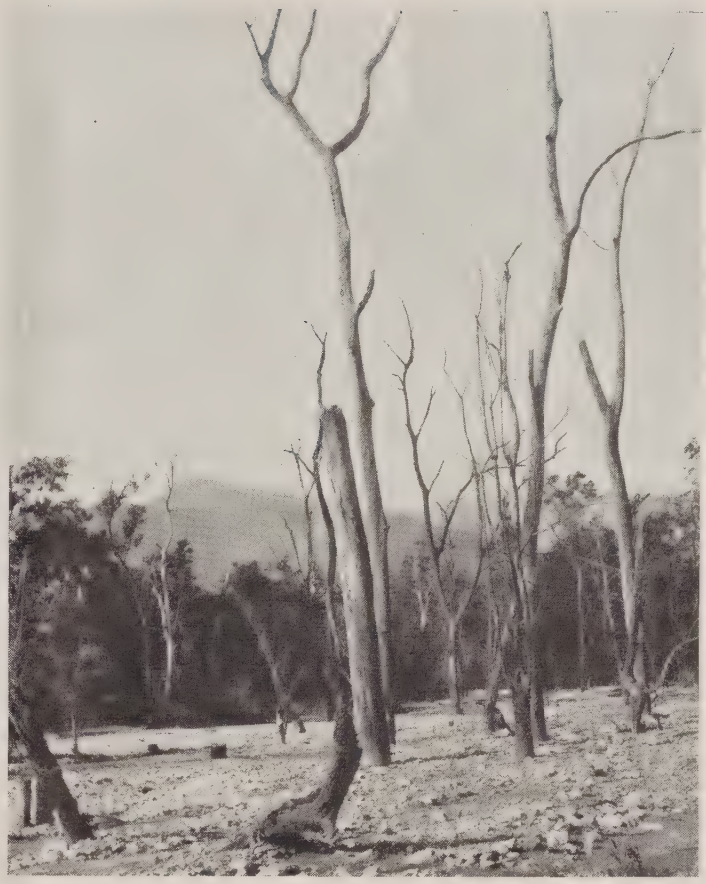
Forest conservation and replanting has been advocated as one of the most effective control measures for the badly eroded areas. However, up to the present time there are only approximately 5,180 square miles out of the total 35,000 square miles of badly eroded territory that are under the control of the Forest Service. Therefore, it will be necessary to go outside these areas if any effective reduction in erosion injury is to be accomplished. Until recently, the Punjab forest officers have advocated closure to grazing as the only feasible means of restoring the plant cover to its natural conditions and thus reducing the run-off and loss of soil. This will still be the main line of attack but it is now hoped to extend work under the Agriculture Department into a broader program of land use and land improvement which will deal with bad agricultural methods as well as overgrazing. Much of the present erosion loss has taken place in areas where no department of the Indian Government has made itself responsible for teaching and improving local practices. Projects have recently been outlined which call for close cooperation between the Forestry, Agriculture, Veterinary Science, Animal Husbandry, and Revenue staffs. The following program has been proposed:

I. To develop fodder resources for local livestock:
   - (*a*) Rotational closures.
   - (*b*) Partition of shamlat.
   - (*c*) Panchayat management.
   - (*d*) Intensive improvement of natural grasslands, including "gully plugging" to stop active erosion.
   - (*e*) Develop tree fodder supply.
   - (*f*) Develop green fodder crops and silage.
   - (*g*) Research on correct grazing incidence.
   - (*h*) Restrict nonright holders and immigrants' livestock.

II. To improve standard of cultivation:
   - (*a*) Better terracing and leveling of fields.
   - (*b*) Discourage downhill ridging for potatoes.
   - (*c*) Find good legume or grass crop to sow on fallow and plough in as green manure.
   - (*d*) Encourage use of compost manure.
   - (*e*) Control nautor grants (permission for fresh cultivation and refuse all for steep slopes.)
   - (*f*) Consolidation of holdings.
   - (*g*) Cooperative tree planting.
   - (*h*) Use of live hedge plants to replace thorn cutting.
   - (*i*) Contour drains in tea gardens and orchards.
   - (*j*) Stream training to reclaim cultivable land along torrent channels.

"Bandhs"—Unique Sedimentation Basins

In the past some of the most intensive schemes of erosion control have been carried out as a part of the



Result of the deforestation of the hillslopes above government forest, Bhutan Native State. (Photo by B. C. Sen Gupta).

programs of famine relief. Smythies[3] has given a detailed description of the methods employed in such an undertaking. In brief, the procedure has involved a combination of stream and gully control combined with replanting, together with the restriction of grazing in the treated areas. One of the principal features of this system of reclamation is the formation of sedimentation basins or "Bandhs" in the tributaries of badly eroded and gullied streams. The layout for one of these "Bandhs" is shown in the accompanying figure. The principle of the operation is extremely simple. It consists in putting well compacted earth dams across a tributary and cutting a water outlet in a higher portion of the stream so that excess water can have a chance to reach the main channel after it has deposited its load of sediment. This "Bandh" operation is combined with the development of many small terraced pits which are built out along the sides of the ravines and on the steeply sloping land.

The idea behind the development of such a system of pits is similar to that of our methods of pasture ridging and furrowing. Water is impounded which would

[3] Smythies, E. A. Afforestation of Ravine Lands in the Etawah District United Provinces, Indian Forest Records, vol. VII. part VIII. 1920 pp. 217–249.

(*Continued on p. 21*)

The Transvaal bushveld in its natural state.

South African Problems Parallel Those of Great Plains

By Lois Olson [1]

Photographs by J. D. Scott, Department of Agriculture and Forestry, Union of South Africa.

In many ways the eastern two-thirds of South Africa resembles the central and southern Great Plains of the United States. Both are comparatively young countries and in both white population was superimposed upon a native nomadic population. The climate of the two areas varies from subhumid to semiarid. When it does occur, the rain is likely to be concentrated in heavy storms. Periods of drought and heavier-than-average rainfall occur at irregular intervals and may last for a few months or continue over a period of years.

The heavier rainfall encourages the areal extension of agriculture or grazing. Retrenchment and economic loss accompany periods of drought. During the more protracted periods of abnormal rainfall prophecies that the climate is changing are current. The initial settlement of the Great Plains seems to have occurred during a period of heavier rainfall and, in consequence, it was commonly believed that the rain followed the plow. In South Africa the rainfall of 1890–92 has not been equaled during the years following. This has led to the common belief that the country is gradually becoming drier, despite the fact that there is historical evidence of equally severe droughts in the past. In both regions overgrazing has resulted in a deterioration of the vegetation, erosion has reached the stage where it can no longer be adequately controlled by individual effort, and the respective governments have initiated coordinated attacks upon the problem.

Long before the coming of the white man the Hottentots and their cattle were well spread over southern Africa. Fire was their most effective tool for clearing land for cultivation, capturing game, and fighting their enemies. In consequence, it is probable that the background for erosion in South Africa was established before white settlement. The cattle trade of the Cape began in 1503 when Vasco da Gama, on his second voyage around Africa, succeeded in purchasing a cow and two sheep. From then on it was a port of call for all vessels rounding the Cape. Cattle and sheep continued as the chief export commodities of the Dutch settlers.[2]

[1] In charge, Erosion History Unit, Section of Climatic and Physiographic Research, S. C. S., Washington, D. C.

[2] For a comprehensive account of the pasture situation see: Hall, Thomas D., South African Pastures: Retrospective and Prospective. South African Journal of Science, vol. 31, Nov. 1934, pp. 59–97.

A farm in the Orange Free State reclaimed by the use of contour banks.

The agricultural area is limited in extent and maize is the chief cash crop. The country as a whole, however, has given up its dream of becoming a second Argentine. From the beginning of settlement, droughts were recognized as a limiting factor to agricultural development and by 1684, it was realized that a 2-years' supply of grain should therefore be kept on reserve. The trekking of the indigenous grazing animal was a result of drought conditions and 4 successive years of drought were basically responsible for the Great Trek of 1836. The custom of trekking which developed thereafter is directly attributable to overstocking during periods of heavier rainfall. By 1751 it was complained that there were too many European families in the country for all of them to secure an adequate means of livelihood. A little later, in 1775, Sparrman said that if the misuse of the land by both farmers and grazers continued "the presage of the country people may chance to prove true, viz, that many spots that are now inhabited and cultivated must be relinquished and suffered to lie waste." Similar complaints have continued and may be found even in current agricultural literature.

Equally important from the standpoint of land deterioration has been the custom of veld burning, traditional throughout much of the African continent and readily adopted by the white settlers. The serious consequences were obvious and in 1687, Simon van der Stel, of the Dutch East India Co., issued the first "placaat" which included penalties for starting fires. These were severe scourging for the first offense and "the cord until death do follow" for the second. The deterioration of the plant cover which followed burning resulted in reduced feed for the animals, overgrazing and finally the introduction of accelerated erosion. It is interesting to note that the drought of the 1860's was by many attributed to the wanton burning of the grass.

The deterioration of the native grassland was of concern at first because of its effect on the animal industries, and it was in this connection that studies of droughts were initiated. The association of both with the erosion problem was of later development. But basically the same causes are responsible for both the deterioration of the pastures and erosion and, in consequence, the cures may serve two purposes. For example, the customary system of kraaling precludes natural recovery of grazed pastures, soil and vegetation deteriorate in consequence, soil blowing begins, and the cattle trails create an erosion hazard. If, instead, the cattle were limited to fenced pastures with rotational grazing it would be possible for the vegetation to recover naturally and the danger of erosion would be reduced proportionately. Similarly, the improvement of pastures by the introduction of new species of grass or by fertilization could be made to accomplish two purposes. The value of such practice was recognized

by farsighted agriculturists at an early date and their general adoption was urged but, as in the Great Plains, the majority of farmers and cattlemen continued their old methods. Experimenting with the production of European grasses to improve the native pastures began during the latter part of the eighteenth century and in 1862 it was suggested that £10,000 to £20,000 should be spent for such tests at an experimental farm. Recommendations for the use of fertilizers also date back to the last quarter of the eighteenth century, but their widespread use is comparatively recent.

Erosion Control Initiated

The close association of erosion with the problems of drought and grazing may be said to begin with the publication of the Final Report of the Drought Investigation Committee in October 1923. Since then the investigation of the erosion situation has made rapid strides. In general this work is closely associated with efforts to reduce run-off and conserve moisture. The program has been approached from three angles which are equally important—education of the masses, research, and governmental control. It is realized that no amount of regulation will compensate for ignorance or apathy on the part of the farmers and that no controls can be effectively employed without their full cooperation. For the past few years practically every edition of the farm magazines has contained information on erosion. These may emphasize the dangers of erosion, the results of controlled experimentation, or the experience of farmers who have successfully checked erosion on their lands.

Ecological Investigations

The results of both experiment and practical experience show that, with few exceptions, vegetation must be regarded as the basic and principal weapon for fighting erosion and run-off. For this reason considerable attention is being devoted to ecological investigations, which include problems ranging from those of a purely botanical nature to the everyday problems of the farmers. Among these are problems of veld management and reclamation. Indigenous and foreign grasses are being studied to determine their pasture value, methods of propagation, breeding possibilities, and their relative value as soil binders and for retarding run-off.

To supplement the more theoretical studies, investigation is being made of eorosion under the various farm practices in general use in South Africa under similar soil, slope, and climatic conditions. Experiments have been made with corn, cowpeas, teff grass, Rhodes grass, bare ground both cultivated and uncultivated, natural veld, veld both grazed and burned, and close grazing not accompanied by burning.

Maize, the most important crop of the Union, is widely spaced and leaves a large proportion of the soil bare and, as replanting is necessary annually, the soil is completely without vegetal covering for a considerable portion of the year. In consequence, run-off during a 4-year test period amounted to 20 percent of the total rainfall, and was accompanied by rapid erosion. Cowpeas, when planted in widely spaced rows as is corn, are about equally conducive to run-off and soil erosion. Teff grass (*Eragrostis abyssinica*), an annual hay crop, has the advantage of providing several cuttings a year but is less effective than the sowed perennial Rhodes grass (*Chloris gayana*). It is urged that under no circumstances should the ground be left bare. In the case of planted grasses, it is the bare period at the time of resetting which is chiefly responsible for erosion losses.

Grazing and Burning

On the undisturbed veld both run-off and erosion are negligible. If the veld is overgrazed the run-off and erosion increase with the amount of grazing, but even this is far less harmful than the more common practice of grazing during the spring and summer and burning in the autumn. Under this type of management the run-off was 27 times greater than on the undisturbed veld during 1933–34, a year of good rainfall.

Of recent years the use of supplementary farm practices, such as contour furrows or ridge terraces, has received considerable attention. In South African Pastures: Retrospective and Prospective, Thomas D. Hall [3] cites examples of veld restoration accomplished by the use of the contour furrows. The stock-carrying capacity was increased, water was stored in the soil, and, as a result, springs developed where none had been before. Favorable results have also been obtained by the use of interrupted contour banks, but under different environmental conditions these may vary widely in size, spacing, and width and spacing of openings.

Government "Schemes"—A, B, and C

To encourage the establishment of counter-erosion works the Government has introduced three schemes under which farmers are subsidized for works approved

[3] See footnote 2.

Sheet erosion following removal of vegetation on the Transvaal bushveld.

and installed. Under *Scheme A* the work is carried on at the expense of the farmer, and the State pays a bonus of 33⅓ percent on the final valuation of all works for which application was made on or after April 1, 1936, up to a maximum of £250 per dam or £500 per farm, provided that one farmer owns no more than three farms. *Scheme B* enables the farmer to secure loans from the Department of Agriculture and Forestry at 3½ percent interest and repayable over a period of 30 years for the building of erosion-control works. The subsidy in this case is 25 percent with a £350 maximum per landowner. *Scheme C* was established to encourage the use of local unemployed European labor during the depression. The laborers are paid 5 shillings and 6 pence per day by the State, one-eighth of the cost to be refunded by the landowner without interest over a period of 50 years. The maximum payable is £350 per dam and £1,000 per farm. Since recovery has set in, the operation of *Scheme C* has suffered from lack of labor supply and farmers are being encouraged to change to *Scheme A*.

By the conclusion of the fiscal year ending August 31, 1936, nearly 13,000 dams at an estimated cost of £1,500,000 were approved under the three schemes. These serve the immediate needs of conserving water for drinking purposes and increasing fodder production, and by facilitating proper veld management, they help to prevent future erosion. During the same period, however, the value of works installed for reclamation and restoration of eroded areas (including contour banks, gully control, repairs, etc.) were estimated at somewhat less than £300,000, in spite of the fact that the need for such work is equally great. For this reason it may be necessary for the Government to grant aid on such a basis that actual reclamation can be properly achieved.

In planning for research and establishing erosion-control works, South Africa has recognized the similarity between environment in that country and in sections of the Great Plains of the United States and has utilized the results of our experience. Similarly, their experience may serve as a check on our procedure, suggest other methods for erosion control, and indicate new lines of research.

THE PUNJAB PLANS A COORDINATED ATTACK

(*Continued from p. 17*)

otherwise escape during periods of heavy precipitation. The earth composing the ridges surrounding the pits is carefully worked down into a fine mulch and used as a planting bed for a variety of forest seeds. The water impounded by the pit supplies sufficient moisture so that a relatively high germination is obtained by direct seeding of forest and foothill species. Smythies notes that in famine relief all members of the community, even small children and elderly people are given employment at a low maintenance wage.

Slowing the in JAVA and

by
Guy · R · Stewart

THE Netherlands Indies consist of a long and relatively narrow band of islands stretching across some 3,100 miles of ocean. They lie along the equator and extend from Asia almost to Australia. The greater part of these islands have a scattered native population. Java, the oldest settled member of the group with an area, including Madura, about equal to the State of New York, is an exception. This island possesses a dense population of some 41,500,000 people.

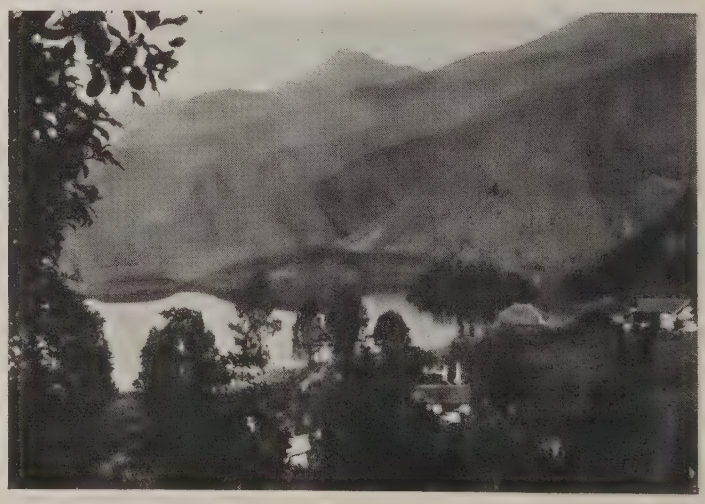
All the islands have a humid, tropical climate, although considerable variations occur with changes in the local topography. The temperatures of the lowlands show a seasonal range from 70° to 91° F., but with each increase in elevation of 500 feet, there is usually a decrease of about 2° F. in

THE PICTURES—This page

Upper left—In North Sumatra the land lies fallow seven years following one year of cultivation. No trees are planted, but the trim tobacco fields soon revert to jungle.

Lower left—As timber makes way for rice fields or plantations in lowlands, the need for firewood and building material results in the cutting of trees on neighboring hillsides. For years there was no thought of reforestation; as a consequence the heavy tropical rains exacted a terrific toll from the soil.

Below—Another view of barren Sumatran hillsides. European rubber plantations having preempted the valley lands, the mountains have had to furnish most of the timber in recent years. The Government is now having to take steps to conserve the soil.



Raindrops SUMATRA

average temperature. Owing to the proximity to the equator there is little difference between summer and winter temperatures, and this makes the change from the low plains to the higher mountains even more

THE PICTURES—This page

Beginning at the top.—Though often unsuited for the growing of rice, hillsides along motor roads are planted to other food crops. Here is to be seen a border of corn and manioc, with various other plants growing between.

On hillside or in valley, every area, however small, is made to furnish its quota of foodstuffs for Java's teeming millions. Not only do the terraces conserve the soil, but every drop of water is made to work over and over again before it is allowed to reach the sea.

Reforestation of the mountain districts, chiefly with **Pinus mercusii** *was designed to combat erosion, to conserve the quality of the soil, to prevent floods, and to provide both timber and turpentine.*

In the Outer Possessions, where the population is thin and relatively little attention is given to the production of rice, the fields are usually located in low spots where water may be easily conserved. In such cases little attention was formerly paid to the hills, except as sources of firewood and timber.

So important is the foodstuff situation in Java and so precious is every drop of water used in cultivation, that the Government has for many years been developing systems of dams, canals, and sluice-gates in order to supply water to the rice fields in the dry season.

striking. In addition to the decrease of temperatures with increasing elevation, greater cloudiness prevails in the higher hills and a heavier precipitation. In the mountains there are likewise a larger number of light showers instead of the heavy tropical cloudbursts of the lowlands.

The rainfall is relatively abundant in all the islands and few places receive less than 40 to 50 inches per year. Precipitation of 120 inches and more is not uncommon in the mountains of Java, Sumatra, Borneo and Celebes. The highest precipitation recorded is in one of the mountain valleys near Kranggan, Java. Here the annual rainfall ordinarily is about 270 inches.

Topography Unusual

Those two portions of the archipelago which have been most intensively developed, and thus exposed to soil erosion, are Java and Sumatra. Both islands are long and narrow, with strongly developed mountain ranges, occurring on the south coast of Java and on the west coast of Sumatra. The ranges are so placed that the rivers which run to the south in Java or to the west in Sumatra are rapid torrents with a steep drop. As a consequence, very little silting takes place along these streams, the currents being sufficiently rapid to remove any soil and debris and carry it out to sea.

In the streams running to the north in Java and the east in Sumatra, the courses of the rivers are longer and more winding. The streams may carry silt and at times form fertile, alluvial deltas; or they may even build up bars at the river mouths to interfere with shipping.

The central mountain ranges on both islands are extensive and thus most of the land is sloping or steep in character. Hence, agricultural operations have largely been adapted to steep or even precipitous hillsides.

The original cover on both islands consisted of a dense, tropical jungle of tall trees with rather light understory of shrubs and herbaceous plants. A variety of tropical hardwoods abounded. Along the coast a number of species of palms were found, as well as bamboo groves, and in swampy places, mangrove thickets occurred. While this heavy vegetative cover remained undisturbed practically no erosion took place.

One of the first points to be considered in studying the factors which have contributed to erosion are certain outstanding differences in the origin of the soils of both Java and Sumatra. On the island of Java, over two-thirds of the land is derived from the weathering of relatively recent ash or lava flows. These soils, often spoken of as the younger volcanic red soils, have been found to be notably more resitant to erosion than the older tertiary soils which occur over approximately one-third of the island. Rutten [1] has shown that this difference is clearly reflected in the quantities of silt carried by the rivers to the sea. In the streams flowing from the older tertiary formations he found amounts of soil which were equal to a soil loss of 1 millimeter up to 5 millimeters of the land area per year, whereas in rivers where the weathered soils have been derived almost entirely from the recent volcanic rocks,the amounts of silt were only equal to a loss of 0.1 to 0.4 millimeter of the land area.

The soils of Sumatra are derived from a greater variety of formations than are those of Java. There is a larger proportion of tertiary rocks which have weathered in some cases to form relatively sandy soils. These soils are extremely short-lived in their period of productivity. This high variability in the fertility of the Sumatra agricultural lands may account partially for the fact that native settlement in that island has not spread and increased from relatively early times with such rapidity as in Java.

In considering the productive life of the soils of tropical regions, such as Sumatra and Java, Mohr [2] has pointed out that the average soils deteriorate under cultivation at a much earlier period than is the case in Europe. He estimates that only 5 to 10 years are often sufficient to achieve the same reduction in the content of organic matter and productive capacity which may require 25 or 50 years with European agriculture.

Agricultural Systems Harmful

A second factor of great importance which contributes to erosion in portions of the Netherlands Indies is the system of land use. Mohr has noted that in the European Netherlands a farmer uses a small piece of land and at his death bequeaths this property as his most valued possession to his children. In the Netherlands Indies, on the other hand, the large plantation operator rarely remains more than 10 years on the same plantation and during the whole

[1] Rutten, Voordrachten over de Geologie van Nederlandsch-oost-Indie, pp. 127–129.

[2] Mohr, E. C. Tropical Soil Forming Processes and the Development of Tropical Soils. Trans. by R. L. Pendleton, pub. by National Geological Survey of China, pp. 1–200, 1933.

period attempts to obtain maximum production. The natives, in general, up to the present time, have not felt the same intimate sense of family possession which has been developed by European peasants through long generations of experience. The interest of the native is confined to the production of the soil for the period in which he uses it.

"Ladang" Cultivation

In newly settled regions in Sumatra and in the outer islands where much virgin land has been available, there has been a great deal of "ladang" cultivation; that is, cultivation of annual clearings that are deserted at the end of 1 or 2 years for further clearings of new land. In these clearings which have been used for a variety of agricultural crops, the natives seldom take effective measures to prevent surface denudation. This deterioration is partly due to the failure of the natives to use any soil-improving crops such as legumes, as well as to early erosion. In some sections of Sumatra it has been noted that an entire tribe would move into a valley for a season, burn down a clearing of trees and plant rice or corn, and after the harvest was completed, move on to another valley and repeat the process.

Plantation Havoc

Just previous to and since the World War, the European plantations, especially in north Sumatra, have expanded on an enormous scale, with thousands of acres of new plantations being established on jungle land each year. The trees were felled and burned and all vegetation was removed. The new soil proved to be extraordinarily rich and unusually porous, and growth of the planted crops in many places was excellent. The tropical rains, however, caused a rapid loss of soil which soon wrought havoc both in the fields in which it occurred and on low-lying lands to which the debris was washed.

The result of the combination—European plantations and native cultivation on the mountain sides—has been severe erosion in many parts of north Sumatra. The loss of soil soon attracted the attention of the planters and as the injury to lowland plantations from deforestation and upland planting increased, appeals were made to the Government for aid and assistance. This has led to an appreciable amount of reforestation of the hillsides in Sumatra and a very large amount of terracing of plantation areas.

Beumee [3] has pointed out some of the difficulties which have occurred in the cultivation of erodible tertiary soils of Java. In a region close to Cheribon on the watershed of the Tjikeroeh River, there is excessive erosion which appears to have started toward the close of the last century through pasturage and overstocking of carabao. This excessive use persisted for only a relatively short period, but on the impermeable subsoils common to the region there was a great deal of incipient erosion which led to a hummocky, almost gullied appearance of the pasture land. In some places, on the tertiary formations where the natives have attempted to install rice paddies on steep sloping land, there has been a slumping and sagging of the fields due to mass movement of the soil upon the relatively impermeable subsoil.

Erosion Prevention Measures

Probably the greatest factor responsible for protection of soils in Java and Sumatra is the so-called "sawah" system of wet-land rice agriculture. The success of this type of cultivation depends on a thoroughly worked and wet seed bed, in flat terraces, and growth under water until the crop is practically mature. The slow circulation of the irrigation stream is sufficient to prevent serious washing or loss of surface soil. Another factor which helps to reduce erosion is the intensive development of plantation terracing which has gradually evolved in both the islands. Since the recognition of destructive erosion in Sumatra, it is not unusual to see individual terraces for each separate tree on the rubber plantations. Various modifications of the system of terracing have also been worked out by the tea plantations for cinchona, cocoa, coffee, and the other upland crops.

Experimental Work

In addition to these practical developments for control of erosion considerable experimental work has been carried out, largely under the Forestry Experimental Station. Some of the work has been reported by Haan.[4] At an important experimental area on the slopes of the older Patoea Volcano south of Bandoeng run-off and stream-flow measurements have been made; and more recently, experimental installations were set up on an area of 150 hectares near Madja in the resi-

[3] Beumee, J. G. B. 1936. Manuscript "Communication on Soil Erosion in the Netherland Indies."

[4] Haan, J. Hde. Boschhydrologische problemen en onderzoekingen op Java. Tectona XXVI 1933 pp. 1–56.

(*Continued on p. 28*)

SAND RIVERS OF CHINA

(Continued from p. 4)

The proper use of trees to protect dikes. A growth of willows, which will stand submergence provided the crown is above water, is a very effective way to reduce the impact of currents against dikes.

In southern Honan, at the headwaters of the Ma Ho, a secondary tributary, one may find this proverb:

Mountains empty,
Rivers gorged.

It is supposed to mean that when the mountains have been deprived of vegetation, the streams are filled to overflowing with sand. The figure is that the rivers have eaten to their full. These and other local proverbs are evidence which is of even greater importance than the judgment of individual men. In order to crystallize thought into a proverb, processes must have reached a degree which not only has attracted the general attention but has produced a consensus of opinion regarding them. These proverbs, therefore, are believed to indicate that erosion of the mountain lands has reached an advanced state.

"Mountains Empty"

The sand deposits and the movement of the sand down the streams of the Hwai system appear from the evidence to have been in motion only a comparatively short time. Evidence indicates that the sand is moving down the stream channels at the rate of 3 to 5 li or 1 to 1½ miles in some years. For it is probable that the rate of movement is not uniform but irregular. The sand deposits, therefore, manifest an extensive area in the watershed of these mountains which has been bared to the direct wash of rain water run-off. Yet the quantity of sand is too great to suppose that it is the direct result of cultivation within as long a time as the past five centuries. It seems more probable that much of the sand had accumulated near the slopes of origin simultaneously with the laying down of the clay deposits. But it doubtless was set in downstream movement in very recent times by unusually powerful currents of run-off which the baring of a landscape to excessive erosion would produce. It seems possible thus to explain how previously accumulated supplies of sand are being washed down the stream channels by increased torrential flows of run-off water as a result of extensive denudation of sloping lands within the watershed.

The removal of the vegetative mantle from the Hwai watershed slopes is more satisfactorily ascribed to the results of human occupation than to a change in climate, particularly since the present climate suffices to produce a dense and complete cover in unmolested regions typified by temple forests. The present extensive cultivation of sloping lands on gradients up to 100 percent is held responsible for the lack of a complete mantle of vegetation as well as for the acceleration of erosion above the erosion norm of the region and for the increasing amounts of coarse and sandy sediments which are moving down and filling to overflow the river channels.

Today the problem of the vast Hwai Basin is twofold: First, the sand rivers which are working downstream to fill up the main channel; and, second, the serious erosion at the headwaters of the tributaries and of the Hwai proper. These problems can be approached with hope for success only after the preliminary cover and erosion surveys already made are extended to the whole watershed to determine what tributaries deliver the bulk of the flood waters and the rate of erosion, shoaling, and the necessary corrective measures. It will be necessary, also, to measure the rainfall in the mountains, which will involve a continuation of the present meteorological stations and the establishment of additional stations whereby the mountainous areas will be equally represented with the plains.

Continuance of the study of the hydrology of the Hwai is extremely important and should include the establishment of stream gaging stations on the tributaries and the Hwai proper at strategic locations. The measurement of the silt content of the run-off waters should be made at these stations with the object of determining the rate of supply of sand to the streams, the movement of the sand downstream, and possible and practicable measures for controlling the excessive erosion. The study of the sand now in motion is particularly important because of its effect upon the permanency not only of transportation on the Hwai but of the permanency of the conservancy works

which must be employed to drain the flood waters rapidly to the sea.

Once the surveys and installations are completed, it should be possible to set in motion operations for feasible measures to control the erosion at the head-waters of the tributaries and of the Hwai proper. With the erosion-control measures established, increased values and enlarged revenues from reclaimed agricultural lands should balance engineering costs.

With regard to the temple forests and enclosures in China, their importance as areas for measuring experimentally the distribution of rain water into run-off and infiltration cannot be overemphasized. These temple forests are of tremendous scientific value to China and should be protected from molestation in the way of clearing and cultivation of the soils. In fact, the temple forests would make excellent sites for experiment stations to which should be added an area of adjacent cultivated lands on which comparative studies might be carried out.

Erosion control in the great loessial area of China is a tremendous task. It should be attacked first in an experimental manner, with intensive appraisals and studies of surface erosion conditions, gullying and river bank and river bed erosion. Soil studies will determine the kinds of vegetation suitable to the various localities. Not the least important is the problem of radical change in farming systems which will need to be introduced before slope reforestation can be developed to any remedial degree. It is fully realized that the present population engaged in the production of tea, China root, corn, wheat, and rice, shrub and small tree timber for fuel, cannot be expelled from the lands for the long period required for the planting and growth of permanent forests.

Plan Taking Form

In no sense can it be said that the Chinese people are unaware of the serious condition of their lands and waters. Slowly but surely, in spite of extraordinarily unsettled political conditions, banditry interference and inadequate financial support, the plans for conservancy operations are taking form. In a letter received recently from Mr. S. Eliasson, of the Yellow River Commission, he states that funds have been allocated for a few experimental soil erosion control stations, and that the hydrometric work on the Yellow River is yielding some extremely interesting data. To quote Mr. Eliasson, "Since 1932 the rainfall in northwest China has been above average. Floods in

An eroding slope which was formerly in forest cover. Where the culture of China root has been practiced, erosion has taken place.

the Yellow River were serious during all the following summers, but the silt percentage in the run-off has been gradually diminishing. There can be no question in my mind that the cause for this is the steadily increasing vegetation cover due to the greater rainfall." With changed farming systems and land use, giving vegetative cover a chance to establish itself, the same results may be noted within a surprisingly short time in the sand rivers that form the Hwai system.

Under the leadership of Mr. Eliasson, K. C. Hou, chief of the Soils Division of the National Geological Survey of China, M. S. Chang, Forestry and Reclamation Department of the Yellow River Commission, and others, the Chinese are anxious to pattern their soil erosion control program after the one now well under way in the United States. In Mr. Eliasson's article, Soil Erosion and River Regulation, published in the Journal of Chinese and American Engineers, the following paragraph gives us an idea of the plan now under formulation:

"Ploughing along contours on sloping, non-terraced ground will have to be adopted in order to hold the rainfall so that it does not tend to carry off the top-soil or develop gullies. Strip cultivation will have to be introduced whereby strips of erosion-resisting plants alternating with parallel rows of cereals will provide additional safety against surface wash of the soil and gullying. Special consideration will also have to be directed toward the areas near the foot of the mountains where the rainfall comes rushing off the mountain side or down the gullies, tearing away the loess cover. But here there are good materials to work with to make drift and check barriers and there is no doubt that this phase of the problem can be successfully tackled. It is being handled successfully in America. Why not in China?"

BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

CONSERVATION OF THE SOIL. By Dr. A. F. Gustafson. New York and London. 1937.

Here is the newest text on current work in the field of erosion control, written by a professor of soil technology, which emphasizes decidedly the agronomic viewpoint. While all types of erosion are covered the author is especially concerned with the introduction and maintenance of protective vegetative cover for the soil and the kinds of crops applicable to this purpose. As a text for schools, for landowners and operators, or anyone interested in checking land wastage, the book is admirable since it presents the general picture in a simple manner and gives definite information for planning and applying soil-conservation methods. The discussion of erosion by actual volume of soil, by plant nutrient value loss, and by destructive deposition, is excellent from the standpoint of popular educational needs.

As to natural factors affecting erosion of the soil, special attention is given to precipitation distribution and intensity and the importance of long-time detailed rainfall records for planning soil-erosion control on arable lands and for flood protection. The subject of latitude as influencing erosion is treated briefly, the main idea being that rapid thawing of unprotected soil, if accompanied by warm rains, results in serious loss of topsoil.

Rather extensive treatment is given to slope and soil type as affecting rate and extent of erosion under varying land cover and utilization conditions. Various soil characteristics are discussed as to size of particles, tilth and porosity, depth and water-holding capacity, subsoil absorptive capacity, and uniformity of composition. In a section dealing with vegetative cover as protection against erosion some interesting tables are included to show effects of different types of cover on losses of soil and water. The treatment of crops and tillage as affecting erosion contains some general statements regarding the use of hay crops, small grains, pastures, rotations and fruit crops as opposed to the continuous cultivation of clean-tilled crops which may be classed as educational material for schools rather than as advanced studies for the trained conservation technician.

The greater part of the book is given over to a description of practical measures for the control of soil losses through erosion. "In a broad general way", writes Dr. Gustafson, "the most important single factor in preventing erosion is the production and maintenance of a complete vegetative cover for the soil. * * * The maintenance of the organic-matter content of the soil, fertilization and liming for the production of good crop yields and an adequate vegetative cover for the soil, contour tillage and seeding, and contour strip cropping are essential in any complete soil-erosion control program under normal conditions. For control of erosion under abnormally high-intensity rainfall, however, the use of interception or diversion ditches and terraces, in addition, is of utmost importance in many sections of the country. In fact, reasonably complete control of erosion, especially under the less favorable conditions, can be hoped for only when all the known control measures are applied intelligently to the entire soil-erosion problem."

For maintenance of organic matter in the soil, the author emphasizes the importance of using barnyard manures, crop residues, green manures, cover crops, and the following of a definite rotation plan. Considerable experimental data from various stations is given in support of cover crop and rotation systems suitable to the soils, climate, and feed- and cash-crop requirements of separate regions of the United States.

Much of the material on principles and precautions of erosion-control methods is credited to the Soil Conservation Service. Adaptation of method to soil type is stressed as of utmost importance in planning for contour tillage and planting. For developing a suitable system of strip cropping it is recommended that the soil conservationist obtain all data possible on the agricultural set-up of the area in which he is working, and in addition that he compile climatic charts, soils and slope and cropping maps, and that the projected strip cropping lay-out be superimposed upon the crops maps.

MAINTAINING ENGLISH SOILS

(*Continued from p. 13*)

above, appropriate artificial fertilisers are used in addition, and their efficacy is most apparent on soils organically well built. Large quantities of factory by-products such as shoddy (wool waste), hoof and horn, bone, etc., are used particularly on market garden and fruit farms, hop gardens, etc., or where farmyard manure is not available.

The cultivator's growing concern for the welfare of his soil is being shown in England at the present time by increased interest in methods of composting (controlled decomposition) in specially made heaps, all forms of waste organic material from hedge trimmings and cereal husks, to Autumn leaves.

The selling of such products as milk, mutton and lamb, cereals, etc., off the farm is a constant drain on the soil's resources, and in countries where there are elaborate sanitary drainage systems this loss is a real one to the land for at least a generation, as valuable plant food is directed away to non-productive areas or to the sea. Better use should, and could be made of liquid manure. Barren districts of low rainfall, and other infertile areas, could be built up gradually in fertility by growing crops stimulated and watered by liquid manure. At first, any plant that could be established there should be encouraged in order to produce organic matter for ploughing in to build up the soil.

It may not be too much to hope that future health schemes will be comprehensive enough to consider the importance of soil vitality.

SLOWING THE RAINDROPS

(*Continued from p. 25*)

dency of Cheribon. These installations are on clay shale and tuff soils which are extremely susceptible to erosion. In addition, the Forest Experimental Station is carrying out studies at a number of other mountainous regions in order to determine the susceptibility of various types of upland soils to loss from erosion.

U. S. GOVERNMENT PRINTING OFFICE: 1937

Keeping Up With the Latest Publications For S. C. S. Use

For REFERENCE
Compiled by Mrs. ETTA G. ROGERS, Publications Unit

Field offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue

Soil Conservation Service

[1] Advance Report on the Sedimentation Survey of Bayview Reservoir, Birmingham, Ala. November 30, 1935–January 25, 1936. mm. SCS-SS-11. March 1937.

[1] Advance Report on the Sedimentation Survey of Lake Decatur, Decatur, Ill. April 8–July 3, 1936. mm. SCS-SS-12. April 1937.

[1] Advance Report on the Sedimentation Survey of Lay Reservoir, Clanton, Ala. January 27–July 24, 1936. mm. SCS-SS-13. May 1937.

[1] Advance Report on the Sedimentation Survey of Lake Bracken, Galesburg, Ill. July 9–August 15, 1936. mm. SCS-SS-14. May 1937.

[1] Advance Report on the Sedimentation Survey of West Frankfort Reservoir, West Frankfort, Ill. August 19–September 12, 1936. mm. SCS-SS-15. May 1937.

[1] Advance Report on the Sedimentation Survey of Lake Calhoun, Galva, Ill. July 23–August 6, 1936. mm. SCS-SS-16. May 1937.

A Preliminary Report of an Infiltration Study of Some Piedmont and Coastal Plain Soils. SCS-TP-13. mm. May 1937.

Progress in the Adoption of Selected Erosion Control Practices, Coon Creek Area, Wisconsin. 1933–36. mm. SCS-RB-5. May 1937.

Relation of Soil Conservation to Control of Floods and Silting. mm. SCS-MP-17. April 1937.

[1] Soil and Water Conservation Investigations. Progress Report 1931–35. Pacific Northwest Soil Conservation Experiment Station, Pullman, Wash. mm. SCS-ESR-2. April 1937.

Office of Information, U. S. Department of Agriculture

Distribution of the Varieties and Classes of Wheat in the United States in 1934. Circular 424. April 1937.

The Farmer Looks Ahead. Farmers' Bulletin 1774. May 1937.

A Pasture Handbook. Miscellaneous Publication 194. Issued April 1934. Slightly revised February 1937.

Comparison of Various Chemical Quick Tests on Different Soils. Miscellaneous Publication 259. May 1937.

Yield of Even-Aged Stands of Sitka Spruce and Western Hemlock. Technical Bulletin 544. March 1937.

Soil and Water Conservation Investigations at the Soil Conservation Experiment Station, Missouri Valley Loess Region, Clarinda, Iowa. Progress Report. 1931–35. Technical Bulletin 558. February 1937.

Yield, Stand, and Volume Tables for Even-Aged Upland Oak Forests. Technical Bulletin 560. April 1937.

The Effectiveness of Cultivation as a Control for the Corn Earworm. Technical Bulletin 561. April 1937.

Decay in Merchantable Oak, Yellow Poplar, and Basswood in the Appalachian Region. Technical Bulletin 570. May 1937.

Agricultural Experiment Station

Agricultural Research Through Fifty Years, 1885–1935. Bulletin 328. Agricultural Experiment Station, St. Paul, Minn. May 1936.

Biennial Report of the North Louisiana Experiment Station, Calhoun, La. 1935–36. Agricultural Experiment Station, Baton Rouge, La. 1936.

Biennial Report of the Northeast Louisiana Experiment Station, St. Joseph, La. 1935–36. Agricultural Experiment Station, Baton Rouge, La. 1936.

Crested Wheat Grass in Eastern Oregon. Extension Bulletin 494. Extension Service, Oregon State College, Corvallis, Oreg. November 1936.

Crop Adjustment Oklahoma's Opportunity for Soil Improvement. Circular 307, General Series 82. Extension Service, Oklahoma Agricultural and Mechanical College, Stillwater, Okla. Reprint, 1935.

Crops and Soils Information. Bulletin 283. Agricultural Experiment Station, Baton Rouge, La. March 1937.

Effect of Tillage Method, Crop Sequence, and Date of Seeding Upon the Yield and Quality of Cereals and Other Crops Grown Under Dry-Land Conditions in North-Central Montana. Bulletin 336. Agricultural Experiment Station, Bozeman, Mont. February 1937.

Findings in Farm Science. Bulletin 438. Agricultural Experiment Station, Madison, Wis. March 1937.

Foreign Strains of Alfalfa and Red Clover. What is their Adaptability to Illinois? Bulletin 431. Agricultural Experiment Station, Urbana, Ill. March 1937.

Forty-Ninth Annual Report, 1936. Agricultural Experiment Station, Knoxville, Tenn. January 1937.

A Graphic Presentation of Changes in the Agriculture of Washington from 1930 to 1935. Bulletin 341. Agricultural Experiment Station, Pullman, Wash. December 1936.

How Science Aids Utah Agriculture. Bulletin 276. Agricultural Experiment Station, Logan, Utah. November 1936.

Improvement of Farm Ponds and Watersheds for Erosion Control and Wildlife Production. Circular 361. Extension Service, College of Agriculture, University of Missouri, Columbia, Mo. April 1937.

A Land Use and Soil Management Program for Tennessee. Publication 197. Extension Service, University of Tennessee, Knoxville, Tenn. November 1936.

Liming Coastal Plain Soils. Truck Crop Investigations. Bulletin 91. Virginia Truck Experiment Station, Norfolk, Va. April 1936.

A Mixture of Alfalfa and Smooth Brome Grass for Pasture. Circular Bulletin 159. Agricultural Experiment Station, East Lansing, Mich. March 1937.

The Nitrate Nitrogen in the Soil as Influenced by the Crop and the Soil Treatments. Research Bulletin 250. Agricultural Experiment Station, Columbia, Mo. February 1937.

Permanent Pastures for South Carolina. Bulletin 99. Extension Service, Clemson Agricultural College, Clemson, S. C. March 1937.

The San Dimas Experimental Forest. California Forest and Range Experiment Station. Berkeley, Calif. June 1936.

Soils of Cascade County. Bulletin 337. Agricultural Experiment Station, Bozeman, Mont. March 1937.

A Summary of Hydrologic Data, Ralston Creek Watershed, 1924–35. New Series 328, Bulletin 9. University of Iowa, Iowa City, Iowa. December 1936.

Types of Farming and Type of Farming Areas in Connecticut. Bulletin 213. Agricultural Experiment Station. Connecticut State College, Storrs, Conn. December 1936.

The Universal Soil Testing System. (A revision of Bulletin 372.) Bulletin 392. Agricultural Experiment Station, New Haven, Conn. March 1937.

Superintendent of Documents
U. S. Government Printing Office

Headwaters Control and Use. Report of the proceedings of the Upstream Engineering Conference held in Washington, D. C. on September 22 and 23, 1936. April 1937. 60c.

[1] Preliminary, limited editions for distribution to technical workers in the Soil Conservation Service and cooperating agencies only.

SOME IMPORTANT INTRODUCED PLANTS USED IN EROSION CONTROL

A more extended list of introduced trees and shrubs used in the erosion control program will be published in an early issue

U. S. F. S. R.
LIBRARY
AUG 2 1937

SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE · WASHINGTON

AUGUST
1937

Contents

Page

Important New Field of Activity Placed in Charge of Dr. Patrick 29

Sunshine and Shadow:
By H. H. Bennett 30

Ohio Valley Launches Extension Program:
By J. S. Cutler 34

Water Spreading at San Angelo:
By R. M. Milhollin and Harold G. Anthony 35

Stabilization of Roadside Banks:
By F. R. Dreibelbis and Helmut Kohnke 38

Heavy Duty Vegetation for Erosion Control:
By R. Y. Bailey 42

Withstanding a Test That Comes Once in a Century:
By R. H. Musser 43

Weed Terraces:
By A. M. Easterday 45

Goforth's Stores Stand Idle—Her Streets Grow Weeds:
By Harold G. Anthony 47

Bringing Erosion Control to Some Highways:
By Arnold Davis 48

Book Reviews and Abstracts:
By Phoebe O'Neall Faris 51

For Reference:
Compiled by Mrs. Etta G. Rogers ..... Opposite 52

Soil Conservation is issued monthly by Soil Conservation Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. Soil Conservation seeks to supply to workers and cooperators of the Department of Agriculture engaged in soil conservation activities, information of especial help to them in the performance of their duties, and is issued to them free by law. Others may obtain copies from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of $1.00 per year, domestic; $1.40 per year, foreign. Postage stamps will not be accepted in payment.

WELLINGTON BRINK
EDITOR

SOIL CONSERVATION

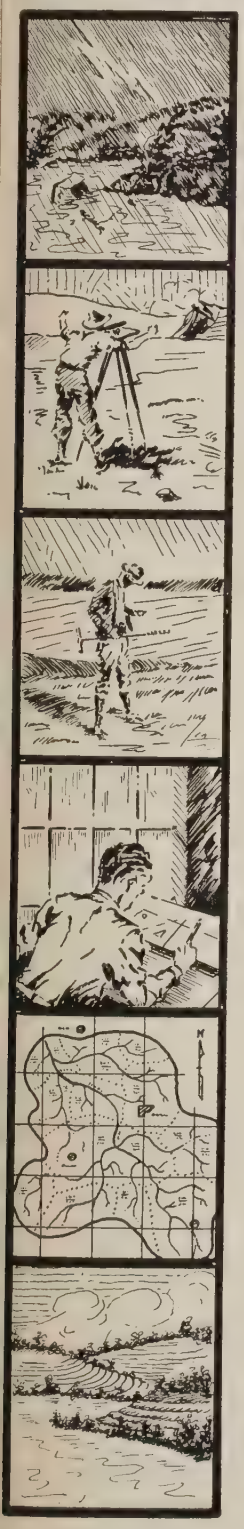
HENRY A. WALLACE
Secretary of Agriculture

H. H. BENNETT
Chief, Soil Conservation Service

VOL. III • NO. 2

AUGUST • 1937

ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON



Important New Field of Activity Placed in Charge of Dr. Patrick

ANNOUNCEMENT is made of the creation of a new division in the Soil Conservation Service to be known as the Watershed and Conservation Survey Division. Dr. Austin L. Patrick, formerly regional conservator in Region 1, heads the new division. Dr. Patrick's early training in soil survey field work and his years of experience gained at the Pennsylvania Agricultural Experiment Station prior to being drafted into the Soil Conservation Service have given him a comprehensive understanding of soil conservation and its related activities and most ably qualify him for his new responsibilities.

The success of the erosion-control program has been due in part to the fact that the plan of conservation operations has been based on an inventory of the physical conditions of the land. The importance of obtaining correct inventories of land features in project areas already in operation, additional surveys contemplated in connection with newly established demonstration projects, legally constituted soil conservation districts, and in watersheds for erosion control and water-flow retardation programs in relation to floods, together with aiding in the determination of the location of conservation problems and plans for proper land use, made additional administrative supervision of the survey work necessary. Conservation surveys developed as a section of the Operations Division and included cartography. These two are now being set up as sections in the new division.

The function of the Cartographic Section consists essentially of map production, including base maps for field surveys, reproduction of field survey maps, and miscellaneous drafting. The work is grouped into aerial surveys, base map production, assembly of field data for lithographing, planimetering of factors differentiated on field survey maps and production of miscellaneous charts, drawings, slides, and exhibits.

The designation of the Soil Conservation Service as one of the agencies of the Department of Agriculture to carry the burden of technical work in the development of preliminary surveys and examinations of watersheds listed in the Omnibus Flood Control Act created a task for which the section of Flood Control Surveys will be responsible. This section will develop policy, outline procedure, coordinate the work of units within the Service and collaborate with other departmental agencies in the review of maps and watershed reports for the flood-control program. It is intended that the field organization of the Service carry the major responsibility for the completion of the watershed reports, with a limited number of especially trained men administering the difficult problems of securing uniformity, accuracy, and completeness of the reports.

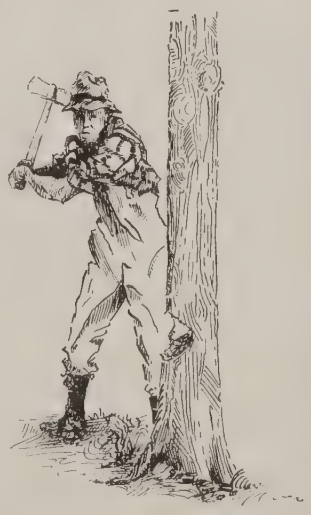
Sunshine and Shadow

By H. H. Bennett[1]

DURING late May and early June, traveling 7,000 miles from Washington into the Pacific Northwest to study the progress of our work in soil and water conservation, I saw a great deal that was encouraging and some things that were discouraging. On the sunny side were men at work on the land who had found the secret of cooperating with nature to conserve soil and water; on the shadowy side were men violating almost every one of nature's ways for maintaining soil balance by living at peace with wind and rain.

In the Footsteps of the Pleistocene

Going westward, I crossed a rolling section of eastern Minnesota, where 31 years previously I had found no gullies and no serious erosion while carrying on soil survey work in that locality. This time, however, it was discouraging to find that many fields had lost most of the rich topsoil that had lain undisturbed many centuries since its formation following the glacial retreat at the close of Pleistocene time—perhaps 40,000 years ago. With the advent of white men, trees and grasses were removed, the land plowed and replowed. Within this brief time the beautiful rolling slopes over which I walked a third of a century ago have begun to waste away.



For 50 miles the train ran through a blinding dust storm in Montana. Muddy rain smeared the car windows. Here, in far too many places, as in parts of the Dakotas, Wyoming, and other Plains States, man has broken down the natural land-defense with plows and livestock—ripped off or degraded the carpet of grass which for centuries stabilized the plains.

From the Spokane meeting of the western directors of extension, I went for a look at the conservation demonstration area of the Soil Conservation Service, comprising the watershed of the South Palouse River in southeastern Washington and adjacent Idaho. Here, on the many critically steep slopes of fine wheat land, the severe erosion observed in previous years has been adequately controlled by the planting of grass, alfalfa, and sweet clover. Gradually this and other practical control measures are spreading out beyond the boundaries of the project. Here and there I saw where black locust, Chinese elm and Russian olive had been effectively used to defend critical areas along the brink of very steep slopes where, without the trees, deep snowdrifts at times have set up serious erosion and started disastrous soil slips during spring thaws. These plantings are serving to spread the snow thinly and so to check the disastrous consequences.

Most gratifying was the nursery at Pullman. This nursery is conducted in cooperation with Washington State College and other agencies. Here, scores of native grasses have been assembled for testing growth habits, germination characteristics, and adaptability for controlling erosion. Breeding work with both native and foreign stock is also being carried on in cooperation with the Bureau of Plant Industry and the college of agriculture.

[1] Chief, Soil Conservation Service, Washington, D. C.

The Chief brings a vivid report of his inspection trip across prairies, plains, foothills, mountains, basins, and sand hills of northwestern trans-Mississippi country

It was a thrilling experience to see some 70 strains of 6 species of blue grass being cultured for the first time. It was equally inspiring to find varieties or strains of the regional bunch grasses and of the Plains bunch grass growing in such a way as to indicate efficiency for improving the range and stabilizing erosion on agricultural land. Some were spreading out recumbently, others were outstandingly broad-leafed, and still others revealed interesting characteristics as to manner of growth and hardiness for special conditions of slope, climate, and soil.

Seeing this work under way on a large scale, directed by energetic, enthusiastic plant specialists, working day and night to find new tools for combating soil and water wastage, was enough to make one wonder why we had waited so long to explore the wealth of wild plants growing across the domain of America, to test the implements that nature has provided us.

I was glad to know that the South Palouse River was again flowing—had, indeed, flowed throughout 1935 and 1936, one of the driest seasons on record. For years, following the breaking up of the native sod, the South Palouse had run practically dry in late summer—and now it has again sprung to life, apparently as the result of the extensive conservation work carried out over its watershed.

Irrigating off the Contour

When the Spanish conquerors ascended the lofty ranges of Peru, the Incas were practicing a highly effective system of soil and water conservation by skillfully building soil-holding walled terraces along the precipitous mountain slopes and applying to the crops grown on these contoured shelves water brought from nearby

and remote places through ditches and tunnels. The soil thus held in place has been safely cultivated across the centuries. Many of the terraces that were in use when Pizarro overthrew the great southern civilization are still being farmed. And, in the Philippines, the head-hunters of the mountain ranges were similarly utilizing and conserving soil and water when the Spanish entered that part of the Orient.

This principle of utilizing water on the contour is thousands of years old; it is a fundamental element of safe land use, as well as safe irrigation, and the practice is probably as old as civilization.

It makes one bow with shame to find Americans practicing downhill irrigation such as we saw on some thousands of acres of steeply sloping land in an important irrigation district of south-central Washington. We found this most wasteful method of using water in operation in numerous steep fields. W. A. Rockie [2] and I measured some of the results of erosion from a single application of water to a pea field by determining the dimensions of the little gullies that were carved along the interrow gutters. The measurements showed that on a slope of about 35 percent, from one-half to two-thirds of an inch of soil was removed from each acre, swept into roadside ditches or deposited in vegetation growing along the foot of slopes. Normally, four such irrigations are made annually, so that the loss of rich topsoil under such conditions amounts to around 2 inches per acre each year. At this rate, it would take only about 4 or 5 years to strip off the rich topsoil and get down to the tough clay subsoil, Actually, we saw some areas in the district which had been abandoned because of this method of irrigating down the slope instead of across the slope along the contour.

[2] Regional conservator, Soil Conservation Service, Spokane, Wash.

I am informed that this wasteful method of using water is practiced in various parts of the West. The farmers say it is the only practical way they can apply water to their sloping land. But it seems to me, if inventive Americans are unable to find practical ways for irrigating sloping land along the contour, then such land, in the interest of the general welfare, the community, and the individual, should be left in grass. I am unwilling to admit that 1937 Americans can be so far excelled by the savages of the Philippines and the descendants of the Incas in the matter of conserving their most indispensable asset. At any rate, we have started on a demonstration at Ellensburg, Wash., where this problem will be vigorously attacked.

Battling the Pacific

Sand-swatters, I believe you would call them—I mean the men at the C. C. C. camp who are now licking the mighty Pacific at its age-old labor of piling shifting, smothering sand over valuable lands and structures fronting our western ocean. The young men of the technical staff who guided us over drifting sand dunes that had been lashed to the landscape, are quiet of voice and mien; you gather that it has never occurred to them and their sand-plugging C. C. C. boys from Boston and other parts of the country that they are carrying on a battle of heroic proportions.

How have they been going about this job of licking the Pacific? you ask. You will be surprised, perhaps, that these sands, seemingly marching irresistibly out of the ocean under lash of wave and wind and threatening to bury investments, buildings, and other improvements valued at $35,000,000, are being calmed with very simple tools. Out there, just back of the lash of ocean, we found them planting Holland grass over the shifting sands. This plant grows prolifically at various points along the Pacific coast. The funny thing about it is that it luxuriates in moving sand. Bury it 2 or 3 feet with smothering sand, and it grows right through, almost as if you had done it a special favor.

Having quieted the sand with Holland grass, other grasses peculiarly adapted to this special job are brought into action. Sea lyme and seashore bluegrass which prefer slowly moving sand, have joined the Holland grass to stop the drifting, and, finally, still-sand plants have come in of their own accord to complete the stabilization. These plants, such as wild strawberry, wild rose, tansy, and fescue have literally rushed in to carpet the dunes. Now all is calm, and will remain so, provided the dunes are not overgrazed or plowed.

There are 20 miles of these dunes extending southward from about the point where Lewis and Clark came upon the ocean. It may not be long until the entire area has been lined up and put to rest by the "sand-swatters."

There is another big job of the same kind waiting down the coast—the towering dunes that line the sea for nearly 50 miles north of Coos Bay. We cannot, of course, permit any mere ocean to spoil any part of such a beautiful coastline as that of Oregon. Arrangements must be made to stabilize these dunes also and to restrict the Pacific to the more beneficial task of washing ashore gaily colored agates and sparkling sand for bathing beaches and delectable razor clams.

Dust Over the Bankers

At Rapid City, I talked about soil and water conservation to a large audience attending the annual meeting of the South Dakota Bankers Association. The very fact that bankers are getting interested in this subject is most encouraging. This Rapid City affair, accordingly, was one of the sunny spots of my trip. I think that the point of view which most Plains bankers share, is that nothing should be left undone until every possible drop of rain falling in that region is conserved. They appear to sense the fact that dust storms cannot be controlled without vegetation, and that adequate vegetation can be produced only through salvaging all the rain water and causing it to sink into the ground where it falls or to repose in a stockpond or small irrigation reservoir.

Although the landscape about Rapid City was green with grass and other vegetation that had sprung to life as the result of recent rains, a dust storm swept down from Montana, or over from Wyoming, just before I came on the program, and this, of course, served as "spot news" for me. Plenty of other material was available, however. During the forenoon, I had seen some of the work carried out by our soil conservation

C. C. C. camp—Camp Robert Fechner—near Sturgis, which is not far from Rapid City. Here, fallow land, stripped with small grain, had been basin-listed in some fields and contour-listed in others. Every drop of a 2.37 inch rain falling on May 30, just 4 days before the bankers convention, was held and stored in the soil. The pasture-contouring had also worked so effectively that I now have no further fear about the eventual adoption of this practice on a far-reaching sacle through the Plains country.

On this project, farmers and livestock men are cooperating splendidly, as are also the officers of the Cavalry post at Fort Meade. All the average man who knows anything about that part of the country needs to jolt him into full realization of what can be done, and what should be done, is a trip over one of these soil- and water-conservation projects after a rain.

While at Camp Fechner I had the pleasure of carrying on a bit of irrigation in a vegetable garden, with water syphoned from a stock-pond built by the camp boys.

A Glutton for Water

L. L. Sloan, project manager at Winner, S. Dak., came up from Kansas in 1935 to join our forces in combating the malignant dust storms that were kicking up general soil chaos on the undulating plain about Winner. He, like everyone who knows anything about the control of dust storms, recognized in the beginning that you cannot get control without vegetation and that you cannot get vegetation without water. We have been told time and time again that man cannot make it rain, and there seems to be some truth in the observation. But Sloan, and others like him, came along and upset this theory.

While Sloan, of course, did not actually increase the rainfall over the Winner project, he did what is the equivalent, insofar as plant life is concerned. Rains had not altogether stopped falling in the region; they simply began coming at longer intervals and in smaller quantities, so that parts of the country dried up and began to blow away. More moisture was created for crops and grass by simply catching the rain in contoured, strip-cropped basin-listed fields and contour-furrowed ranges. Water that otherwise would have run into the nearest stream and off in the direction of the Gulf of Mexico, was trapped and held for the growth of grass, grain, and other vegetation.

It rained all the day following the bankers convention, and as we drove from Rapid City to Winner, S. Dak., the precipitation was heavy enough to bring the rivers that we crossed into flood condition. When we got out on the work around Winner, it was easy to see that every drop had been trapped and saved for future crop use, except that running down roadsides; and in some places even this had been saved where dams had been thrown across the ditches and the water diverted to fields and pastures.

Lack of Appreciation

Crossing southern Iowa, we saw through train windows many fields gullied by erosion and others spotted with erosion-exposed yellow clay. All of these had once been clothed with grass or trees. Denuded of their protective cover and cultivated up and down slope, these lands that once produced 50 bushels of corn per acre without fertilizer have reached in many instances a state of abandonment.

In conversation with some women who were traveling eastward from Montana and Nebraska, I inquired why the farmers were plowing the curious ditches—the gullies. Thereupon, developed considerable discussion of land use, good and bad. One woman, who had farmer relatives, guessed the ditches had been plowed to control the advance of chinch bugs. Another insisted that the clay spots had always been there.

It was not very difficult to convince these loyal citizens of the Plains that the cause of these sore spots on the land was accelerated soil erosion. They contended, however, that the problem was one for men rather than women. I was told that they discussed in their clubs principally popular books and recipes for cakes. That led me to ask if they, like other good Americans, should not also be concerned with the preservation of the source of the materials that entered into the composition of the cakes, and of the paper used in the books. I pointed out that in my own case I probably would do nothing but fish the next 6 years but for the insistence of my good wife that I stick to the present job for a while.

I am still wondering whether this last idea went over. I do believe, however, that at least a few more good women may on occasion give some thought to the shadowy pictures one sees in too many localities while traveling across our rolling farm lands and overgrazed plains.

OHIO VALLEY LAUNCHES EXTENSION PROGRAM

By J. S. Cutler [1]

WITH more than a full year to chart the way, the Ohio Valley region is stepping out boldly, yet carefully, on a program extending the principles of soil conservation to its farmers. In four States definite extension programs have been launched in cooperation with State extension services.

The general educational plan has been carried on through the press, the radio, farmers' meetings, institutes, exhibits, and all available avenues. In Ohio, a score of individual demonstration farms have been planned for soil conservation, the Soil Conservation Service providing the technical direction with other details handled by the Agricultural Extension Service. Similar demonstrations are being started in Indiana and Tennessee. Four states in the Ohio Valley region have taken steps to include soil conservation in the list of available 4–H club projects.

Work already done and plans for the future were discussed in a conference at regional headquarters, Dayton, Ohio, last spring when extension directors and extension soil conservationists representing Kentucky, Tennessee, Ohio, Indiana and Michigan, met with State coordinators and regional and Washington officials of the Soil Conservation Service.

Although the recounting of experiences by spokesmen from each State received considerable attention during the one-day conference, it was the plans for the future and the assurance of a coordinated soil-conservation program that proved the conference a worthwhile venture.

Tennessee has launched a program of extension that will make soil conservation a community affair, C. E. Brehm, extension director, explained. More than that, the community program is to tie soil conservation to the individual farm and to the farm home. In emphasizing the farm home in Tennessee, Mr. Brehm said, "Soil conservation and human conservation go together. That's what soil conservation is for." So Tennessee will attack erosion control on an area or community extension basis.

T. A. Coleman, acting director for Indiana, observed that "we are getting out of the emergency era and swinging over into the long-time program." He believes it is necessary to bring the successful farmer into the councils where extension programs are planned—soil conservation included. If Mr. Coleman has his way, Indiana will be in the limelight of 4–H club activity pertaining to soil conservation. "I think the club work is the best thing we have started", he told the conference. "If we give the boy a little this year, a little next year, and so on, by the time he has completed his 4–H club work he will be ready to put what he has learned into practice."

A 4–H club project plan has been completed in Michigan also, and everything is ready for it to go forward this spring—so Paul Barrett, extension soil conservationist, reported. He called attention to the fact that county agents in Michigan have visited the project area at Benton Harbor and have begun to push soil conservation in their programs. As a matter of fact, as Barrett explained, Michigan is definitely soil-conservation conscious. He cited numerous examples as proof, one of which was the 1937 Farmers' Week program based on conservation, where a record attendance was reported. Michigan wants more of soil conservation.

Director R. H. Baldwin of Michigan Agricultural College said that team work would feature the soil-conservation extension program in the Wolverine State, with each subject-matter departmentre presented on the team. Michigan agencies cooperated to sponsor a soils demonstration train through the State early in April.

In Ohio, all extension specialists are of the opinion that their special problems are "in relationship to soil conservation", as explained by B. B. Spohn, supervisor of projects. For example the livestock specialist asks what effect the adoption of correct land use will have on the farm's livestock enterprises. The livestock specialist, the agronomist, the poultry specialist, the soil conservationist, and others then put their heads together and work out a satisfactory solution. "Thus, in the long run", Spohn observed, "the solutions will be better than if all phases of the problem were not considered."

D. S. Myer, chief of the division of cooperative relations and planning for the Soil Conservation Service, discussed the Standard Soil Conservation Districts Act and sought to chart the course of soil conservation work during the next decade.

(Continued on p. 50)

[1] Regional conservator, Soil Conservation Service, Dayton, Ohio.

Rock wall designed to serve as spreader of water released from pasture terraces on a farm near Christoval, Tex.

WATER SPREADING AT SAN ANGELO

By R. M. Milhollin and Harold G. Anthony [1]

"There is sufficient annual rainfall in the Rolling Plains section of Texas for profitable crop production if it is properly utilized."

THIS statement by R. E. Dickson, superintendent of the Texas Agricultural Experiment Station at Spur, Tex., has been the subject of widespread comment. The station is working in cooperation with the Soil Conservation Service.

The point of Mr. Dickson's statement is, of course, that from the standpoint of moisture for crop production in an area of limited rainfall entirely too much water is lost in flash run-off. Why not divert and spread the available rainfall on pastures and cultivated fields for the ultimate use of grasses and field crops? From his viewpoint, which is backed by experimental results at the Spur station and experiences of hundreds of farmers in the region, the moisture problem in the Rolling Plains is not so much one of insufficient precipitation as it is a lack of those farming methods and practices developed specifically to ensure efficient utilization of the greatest possible amount of the annual rainfall.

On Level Lands

Many level areas with deep absorptive soil are capable of storing larger quantities of water than is available in the form of rainfall. Such is the case in sections of the upper Concho River project near San Angelo, Tex., where the annual precipitation is 21 inches. These level areas offer exceptional opportunities for utilization of run-off waters from the adjacent rolling hills, especially where it is impracticable to build mechanical structures.

Treatment of level areas which are favorable for water spreading offers two major problems—retention of needed water for crop production, and flood control. Both of these problems are largely solved when water is spread and stored in the soil by the use of water-spreading systems. Furthermore, there is no serious soil erosion on areas so treated.

Experience on the San Angelo project has brought out the fact that areas with slopes of less than 1 percent are best suited for water spreading. On steeper slopes the cost of construction in proportion to the distribution of water obtained probably limits their use for such systems. On greater slopes with shallow soils it is more economical to use a "syrup-pan" system of terraces to direct the water to more level areas than it is to construct a protected outlet channel to carry surplus water to the level areas. The fall between terraces can be cared for by the use of nonerosive grade spur terraces particularly on pasture land up to 3 or 4 percent. The cost of these dirt structures has been found to be less than that of a protected channel.

The soils on the more level areas of west Texas are exceptional from the standpoint of texture and depth of storing available moisture. These soils will absorb water at a rate of 5 to 10 inches in a 24-hour period, and from 20 to 30 inches in a 15-day period. Such favorable conditions for moisture infiltration make the upper Concho River project ideal for water spreading. Approximately half of the 100,000-acre area has less than one-half of 1 percent slope. Since very few mechanical structures are used on land with slope greater than 5 percent, enormous amounts of run-off water which is now going to waste may be used.

Two principal methods are adapted on cultivated fields in the San Angelo area to secure the desired results in water spreading. These are "syrup pan" terrace systems and the rationing of run-off water to level closed-end terraces. Minor deviations are, of

[1] Mr. Milhollin is soil conservationist, San Angelo, Tex.; Mr. Anthony is Administrative Assistant, Fort Worth, Tex.

Syrup-pan terraces near San Angelo, Tex. Strip crops and contour tillage.

course, necessary in the basic methods of dropping water from one terrace to the next and in the type and arrangement of stone masonry structures. Some structures such as weeps with float- and weight-controlled flood boards are automatic, while others have simple hand-controlled flood boards that are used to divert water from the channel to the terrace system.

The "syrup pan" terrace system is so named because the water is made to flow back and forth across the field in the same manner that cane juice is made to flow back and forth across the syrup vat. This system on a 120-acre field at the station has been in operation since 1930. This field receives the run-off from 1,200 acres of land. Even before 1930 diversion of a small amount of water from road ditches on to cultivated fields was practiced at the station. Results of this experimental work were responsible for the installation of the "syrup pan" system of terracing, with the various deviations, in the water-spreading program on the San Angelo project.

Rationing run-off water to level closed-end terraces, a deviation from the "syrup pan" system, is being used extensively. The rate and amount of water rationed is determined by the slope of the land, acres within a terrace interval, and the depth and type of soil. This method of water spreading necessitates the use of simple stone masonry structures. Numerous little safety measures are installed in the rationing systems to offset the human element. Usually, these safety devices deprive the farm operator of the advantages of extra water unless he is present to operate them at the opportune time. Several automatic gates are now being developed and these may be substituted later for the hand-controlled installations.

What is known as the crescent system of terraces is being used to some extent in spreading surplus water on pasture areas. This system has numerous safety outlets for water. Rather than "bottle up" the water a number of weeps are constructed in the terraces so that the anticipated volume of extra water may by-pass without endangering the system.

Two general types of structures are being used to ration run-off water. These are weeps and diversion structures. Both open and picket-type weeps are used; and diversion structures may be either channel-stone masonry or open ditches. The weeps are used in diversion levees or as a part of the water-spreading dyke. The system diagram shown is an example of the open-type and picket-type weeps used in a diversion levee. Each terrace interval in the cultivated field receives a definite proportion of the extra water.

The picket-type weep is ordinarily used as a part of the terrace. The terrace system is closed in the same manner as level, closed-end terraces, and at these close-ups a picket-type structure is set in the angle between the terrace and the end level. The stone pickets are set up as a part of the terrace at the natural draws in the field and are staggered in such a manner that the water flowing through a picket structure collects on the next terrace before the weep in the lower terrace begins functioning.

The second type of structure used to ration run-off water is an open ditch to feed water out of drains into closed-end terraces. No spoil bank is left where the water is being fed in both directions from the drain.

A look at some of the syrup-pan terraces on the Spur station. Ten times as much cotton was produced here as in 1934 before treatment; the average yield is twice that of unterraced land in the vicinity.

When the ditch is full it is carrying the maximum amount of water into the terrace system. Any surplus flows down the natural drain.

On the other hand, if water is being taken out of the drain in only one direction a spoil bank may be used across the drain. This results in a greater volume in the ditch carrying the water away from the drain. Under this arrangement an emergency by-pass is left to act as a safety factor when the volume of water needed is flowing in the ditch. Stone masonry structures are used to divert water from definite channels into the terrace system. Operation of these structures is by automatic or hand-operated flood boards. It readily becomes evident that the irrigation ditch principle is back of this method.

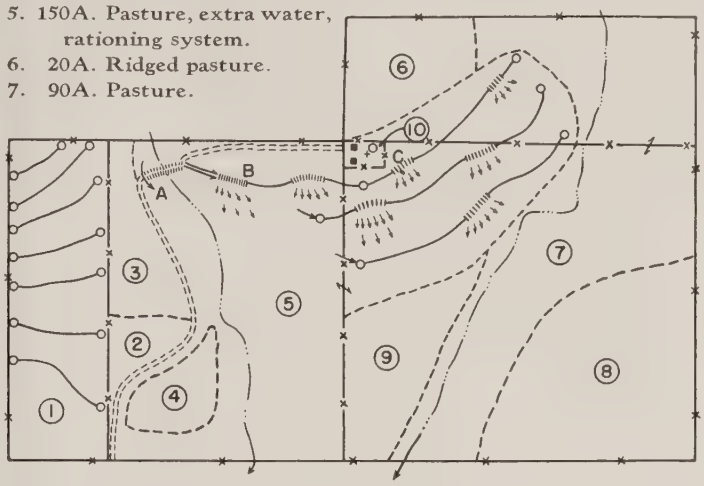
The use of weeps and diversion structures may be combined in the plans for one farm or even for one field. Their application is dependent on so many factors that it is not advisable to discuss them here. Suffice it to say that they are intended to permit utilization of all anticipated run-off.

The designing and building of these structures are so simple that the average farmer should have little difficulty in duplicating them. The open weeps are simply walls and floor beams. The picket weeps are stones set on end in concrete.

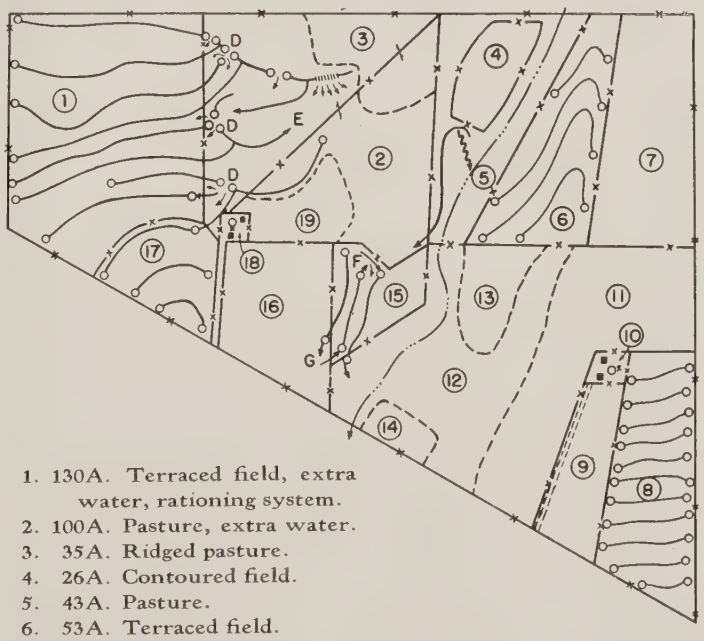
Water spreading system and structures built in spring and summer of 1936 withstood a 6-inch rain in 10 hours, but a few breaks occurred when this storm was followed within 2 days by an 8-inch downpour within a period of 10 hours.

FARM PLAN SHOWING WATER-DISTRIBUTION SYSTEM

1. 60A. Terraced field.
2. 10A. Listed pasture.
3. 25A. Ridged pasture.
4. 20A. Ridged pasture.
5. 150A. Pasture, extra water, rationing system.
6. 20A. Ridged pasture.
7. 90A. Pasture.
8. 80A. Ridged pasture.
9. 25A. Listed pasture.
10. Farmstead.



A—Safety outlet.
B—Rock weep on grade.
C—Rock weep level.
D—Rock inlet.
E—Safety outlet.
F—Graded spur in field.
G—Graded spur in pasture.



1. 130A. Terraced field, extra water, rationing system.
2. 100A. Pasture, extra water.
3. 35A. Ridged pasture.
4. 26A. Contoured field.
5. 43A. Pasture.
6. 53A. Terraced field.
7. 64A. Listed and seedpasture, 32.5A to P.
8. 58A. Terraced field.
9. 37A. Ridged pasture.
10. Farmstead.
11. 75A. Ridged pasture.
12. 80A. Pasture.
13. 20A. Ridged pasture.
14. 12A. Listed and seeded pasture.
15. 40A. Terraced field (extra water syrup-pan).
16. 66A. Ridged pasture.
17. 30A. Terraced field.
18. Farmstead.
19. 20A. Ridged pasture.

The channel-stone masonry diversions may be a combination with the drop type structure. Usually, however, the installation of a part of the flood boards in the structure will eliminate the necessity for the drop type structure. Grass in the channel eliminates the danger of erosion on a 1-percent slope.

Stabilization of Roadside Banks

By F. R. Dreibelbis and Helmut Kohnke [1]

WHEN the research area of the watershed section project was established near Coshocton, Ohio, many fresh roadside cuts presented an immediate problem in erosion control. Without such control, the accuracy of the run-off and erosion data to be obtained would be subject to challenge, and the roads themselves would be open to danger. As to the best method for stabilization of the banks, it was believed that only close-growing plants such as grasses and legumes could adequately serve the purpose. Trees, because of their slow growth, do not provide the immediate protection needed on roadside banks, although their value for erosion-control plantings in other locations is well known.

Poor Sites for Plant Growth

The local soils are residual from sandstone, shale, and clay. They belong to the immature soils of the northern Appalachian Plateau, with Muskingum as the best-known series. The comparatively fertile surface soil is shallow, while underneath this layer the soil material consists mainly of fragments of sandstone and shale or of heavy clay and occasional coal outcrops. As most of the road-cut materials are of this nature, the banks presented a serious problem as sites for plant growth. It was known that the seedbed preparation of highway cuts as practiced by the Michigan State Highway Department, in which the banks are covered with a 4- to 6-inch layer of organic soil, had given very satisfactory results. It was impossible, however, to employ this method in the Ohio area, as peat and muck soils are not found in the immediate vicinity. After considerable study it was decided to use mulching as an aid in growing the grass and legumes on the banks—this in view of the fact that Dr. K. Lehotsky [2] realized unusual success at the Salt Creek project in the establishment of herbaceous vegetation in gullies by means of various mulches. Some preliminary work which had been done in the spring of 1936 served to provide information on seedbed preparation and on suitable plant species. In August of 1936, specialization work began on about 2¼ miles of roadside banks in the Coshocton watershed experiment area. This work is herein described in detail.

[1] Assistant soil technologists, Soil Conservation Service, Coshocton, Ohio.
[2] Associate forester, Soil Conservation Service, Coshocton, Ohio.

The seedbed was prepared (1) by properly sloping the banks, (2) by raking the seedbed, and (3) by rounding off the intersection of the cut and the undisturbed soil.

The banks were graded at a slope of 60 percent or less, and no banks were seeded where they exceeded this gradient for more than 1 or 2 rods. The seedbed was then raked parallel to the contour with a steel garden rake, and, to reduce erosion, the raking grooves were kept perpendicular to the flow of run-off water from the banks. The tops of the banks at the point of cut and undisturbed soil intersection were rounded in order to avoid an abrupt slope transition. This prevents drying out and sloughing off and allows this part of the bank to be planted.

As a standard seed combination, the mixture was used in the ratios as follows:

Seed	*Percent of total weight*
Alfalfa	8.0
Alsike	15.5
Lespedeza	15.5
Sweetclover	4.0
Red clover	11.0
Canada bluegrass	11.0
Orchard grass	8.0
Redtop	11.0
Timothy	8.0
Oats	8.0

(Inoculants for the legumes were also included.)

In this vicinity, red clover, alsike clover, and timothy are the standard plants used in meadows; while orchard grass, redtop, and Canada bluegrass frequently are found in old meadows or along roadsides. All the legumes were used because they had shown promising growth in the preliminary work. Oats were added to the mixture in order to produce rapid growth for quick erosion control. The seed was sown by hand at a rate of approximately 2.5 pounds per 1,000 square feet.

Preparation of Seedbed

After seeding, the banks were tamped to fix the seed firmly in the soil, to facilitate its germination, and to pack any loose soil. The tamper, made in the local Soil Conservation Service shop, consisted of a flat board 15 inches square and 1 inch thick, with a round wooden handle 5 feet long supported by wooden braces. The weight of the tool is 9 pounds.

Check plot between two seeded areas, showing mulch treatment. Seeded May 1936; picture taken July 1936.

Five months after seeding, October 28, 1936. Note contrast between check plot and seeded areas; sweet clover at left, Korean lespedeza at right.

After the banks had been seeded and thoroughly tamped, they were mulched with a compost which had been previously prepared. This was spread uniformly over the entire bank in sufficient thickness to cover the soil. The rate of application was between 500 and 1,000 pounds per 1,000 square feet. There are several reasons for applying this mulch. It retains more of the moisture in the soil by preventing excessive evaporation; it protects the young seedlings from undue exposure to heat and sunlight; it aids in the prevention of erosion from the banks; and lastly, the major nutrients necessary for plant growth are supplied.

Type of Mulch Used

The best type of mulch for these purposes should have the following properties: It should contain a good supply of nutrients; it must be heavy enough so that it will not be blown away by the wind, or washed away by water; and it must cover the ground rather uniformly without entirely excluding air or light from the soil. Ordinary barnyard manure is not quite satisfactory as it is frequently too lumpy. Leaves are not recommended since they may have a smothering effect on the vegetation.

The mulch was made up of a mixture of manure, straw, soil, water, and fertilizers in the following proportions:

Composition of Compost Used

	Pounds	*Percent of total weight*
Manure (approximate weight)	36,000	58.4
Straw (approximate weight)	14,000	22.6
Soil (approximate weight)	10,000	16.2
Hydrated lime	250	.4
16 percent superphosphate	875	1.4
Ammonium sulphate	600	1.0

The available manure was mixed with straw. Soil was added to furnish micro-organisms for the decomposition of the straw and also to furnish some elements necessary for this process. The soil also added weight to the compost which aided in holding it on the road banks.

As straw is high in carbohydrates and low in protein and ash, the addition of nitrogen, phosphorus, and calcium fertilizers was necessary in order to give the micro-organisms a properly balanced ration. Potassium was amply supplied by the manure. Water was added in large quantities. Because the summer was hot and very dry this application had to be repeated.

The compost pile was left to decompose for about 1 month and a fairly satisfactory result was obtained, although 2 or 3 months of decomposition would probably have produced a better cured compost.

Use of Check Plots

In order to compare the results of this seeding work with the unprotected areas, a check plot about 1 rod long was left unseeded and unmulched at occasional intervals along all roads selected. Efforts were made to locate these check plots on areas typical of that road, especially in regard to soil and slope.

Other check plots were seeded but were left unmulched and by this method it was possible to observe the effects of mulching. The unmulched areas showed much poorer growth than the mulched areas. The contrast was made more conspicuous by the dry and hot season which followed the seeding, and by a few very heavy downpours which washed many of the seeds from the unprotected areas.

Protection With Brush

At some points along the road the seeding work was hindered considerably by chickens. These areas were reseeded and the mulch, which was mostly scratched to the foot of the banks, was again spread uniformly over the road bank surface. This was then covered by brush containing many fine branches with leaves, so as to discourage poultry. It is believed that the elimination of oats in the seed mixture might obviate the need of brush protection against "poultry erosion."

Use of Check Dams

At several points along the road where drainage ditches were rather deep and where the gradient was steep, the building of check dams was necessary to prevent undercutting of the banks by the stream.

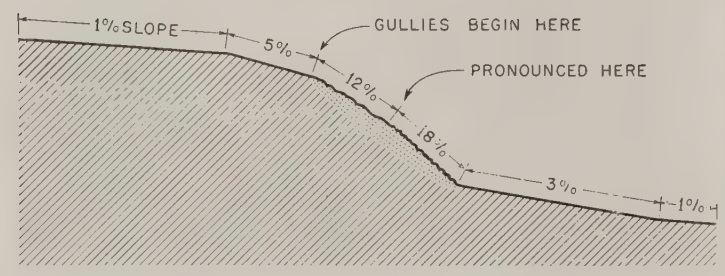
These check dams were made of burlap sacks partly filled with soil to which some of the standard seed mixture was added. Care was taken to scatter the seed on the surface of the soil within the sack. It is necessary to use coarsely woven sacks, as only from this type can the germinating plants gain access to the atmosphere. The filled sacks were then partly buried in the bank with about one-third of the sack extending above the ground surface. Where the ditch channel was wide, one sack was placed on each side of the channel and extending lengthwise up the road bank, and another sack was placed below these two, parallel to the channel. Where the drainage ditch was very narrow only one sack was used.

(Continued on p. 52)

Bank before seeding; July 31, 1936.

Same bank, after acquiring protection; October 28, 1936.

Heavy Duty Vegetation for Erosion Control



By R. Y. Bailey [1]

THE engineer does not attempt to control large volumes of water moving at high velocity with light temporary types of structure. Similarly, the agronomist is just as anxious to select the kinds of vegetation that will bind the soil together to withstand the abrasive action of large volumes of silt-laden water under trying conditions in the field.

Permanent Strips on Critical Areas

At certain places on cultivated slopes, because of degree of fall, type of soil, or previous erosion (or a combination of these), strip crops of annual plants are inadequate. Such areas may be observed in fields planted to small grains or annual hay crops where destructive erosion is uncontrolled during the greater portion of the year. Obviously, if these crops fail to control erosion on these critical areas when planted over entire fields, they cannot be expected to furnish adequate protection at critical points when used in strips. Continuous protection at such points requires a heavier and more effective type of heavy-duty vegetation in the form of permanent strips. In general, perennials must be employed. Alfalfa, perennial grasses, lespedeza sericea, or kudzu are often effective in controlling erosion in cultivated fields at points where the problem is most acute. The kind of plant to be used depends upon soil, climatic conditions, extent of erosion, and adaptation to the conditions peculiar to the individual farm. It is important to select plants that will grow, become established, and furnish active protection. After the critical areas are brought under control, the remainder of the fields may be controlled with other crops used in rotations and strips.

The concentration of water which results from proper terracing presents a serious problem of disposal. Water so concentrated must be transported with a minimum of damage from the cultivated fields to areas protected by trees or permanent sod or to permanent stream channels. Since the trend in water disposal is toward vegetated waterways, agronomists are charged with developing cover in waterways that will spread water over relatively wide areas, relieve it of silt and deliver it to its destination in an orderly manner.

With the trend toward vegetative control in water disposal, properly built terraces increase the demand for heavy-duty vegetation to cope with water concentrated in terrace channels.

In addition to the plants already suggested, the sod-forming grasses are useful, particularly in primary channels where the volume and velocity of the water require the maximum of vegetative protection.

Bermuda is one of the best grasses for this purpose in the Southern States. Farmers sometimes object to it because of the possibility that it may spread to cultivated areas and become a pest. This objection is being overcome in many instances by bordering the Bermuda used in primary channels with lespedeza sericea to prevent its spread. The sericea makes good hay after once becoming established.

(Continued on p. 46)

[1] Regional Agronomist, Soil Conservation Service, Spartanburg, S. C.

WITHSTANDING A TEST THAT COMES ONCE IN A CENTURY

By R. H. Musser [1]

EROSION-CONTROL practices in the West Tarkio River demonstration area in Atchison County, Mo., withstood one of the severest tests in the history of the project on April 21 when 4¼ inches of rain (about 12 percent of the average annual rainfall) fell in 1½ hours. A rainfall of this intensity has about a 100-year frequency.

The rain, totaling 4¼ inches, fell over an area 4 miles wide across the project including the work area of Camp SCS–Mo–3 at Tarkio, on soil which had soaked up a 1-inch rain the day before. The run-off was tremendous, and thousands of tons of productive topsoil were carried away from unprotected sloping fields. With 480 tons of water falling on each acre in 90 minutes the soil had little chance except where it was guarded with a dense cover of vegetation, terraces, or cultural soil-conserving devices.

[1] Acting regional conservator, Soil Conservation Service, Des Moines, Iowa.

The storm presented a perfect demonstration of the need for combined control of erosion and floods. Run-off from downpour in one watershed reached such flood proportions that it washed out a 150-foot wooden highway bridge and carried it one-half mile downstream. Another bridge upstream also was torn from its foundation. In an adjacent watershed the river had overflowed its banks above a highway fill and had deposited an average of 3 inches of silt over a 200-acre bottom field. The fertile soil left on that field by the one rain is equivalent to 7½ inches of productive soil over an 80-acre farm. Fields from which this silt was sliced, in general had little or no protection against erosion, and gullies were cut where rows led up and down hill. Upstream there was erosion; downstream there was a flood.

Terrace outlet sodded in October and November 1936. Terraces constructed May 1936 and September 1936. Sod was not damaged by terrace run-off following 4¼-inch rain which fell in 2 hours. Terraced field is in wheat. Very little erosion occurred. Maximum slope is about 10 percent.

In the West Tarkio area the predominant soil type is Marshall silt loam, which is very absorptive, and the topography is gently rolling. The average annual rainfall is about 32 inches. With a normal distribution of rainfall, several cooperators have been able to effect satisfactory conservation of the soil and rainfall on the more gently sloping cultivated fields by planting corn around the hill on the contour, using a lister planter or furrow opener, and placing the corn in furrows 6 to 8 inches deep.

About 36 percent of the demonstration area is in cultivated crops, principally corn, representing a decrease of more than 8,000 acres since 1934. Under the erosion-control program the acreage of legumes was increased by more than 4,000 acres, but because of the severe drought during July and August last year many legume seedings were killed. The drought seriously damaged permanent vegetation in southwestern Iowa and northwestern Missouri, and as a result a larger percentage of the land did not have sufficient cover to withstand the onslaught of 4¼ inches of rain in 90 minutes.

In spite of the heavy rain of April 21, there was not one failure in all the terraces and gully dams which had been built by the Soil Conservation Service on farms in the West Tarkio project and the Tarkio camp area. Terraces carried the 4¼-inch rain without a break, and spillways to earth dams and terrace outlets which had been sodded in the fall of 1936 carried the overflow water with no appreciable damage.

On one farm in the Tarkio camp area where a terrace outlet was sodded last November to carry run-off from three terraces in a field of winter wheat, the outlet carried 3 to 4 inches of water down an 8-percent slope. There was no sign of cutting in the sod, and the silt deposit was negligible, indicating that the heavy run-off was let down off the field in such a way that very little erosion occurred.

Sod also carried the overflow from an earth dam

(*Continued on p. 52*)

Wheat seeded with one-row wheat drill, in corn, on the contour, in fall of 1936. Being pastured at time picture was taken. Very little erosion apparent after 4¼-inch rain in 2 hours. The stalks were soon to be harrowed down so that the crop could be harvested. This practice provides both fall and winter cover, the latter when most needed. It also supplies pasture in both seasons, that in the fall being supplemented by stalks.

WEED TERRACES

Hard, bare, sandy clay loam fields were an immediate and constant prey to blowing. From this field with its standard terrace soil was swept in such volume that traffic was blocked on the highway.

By A. M. Easterday [1]

SINCE dry farming was first started in the semi-arid west, weed and dust accumulations in fence rows from bare fields have not been un common sights. Furthermore, the heavy and continuous drought of the past 4 years has seriously aggravated the soil drift problem.

Fields planted to beans or other non-erosion-resisting crops and sown crops which failed to produce a protective cover have been most seriously affected. In the Clayton, N. Mex., area erosion from such fields has varied from a few inches to as much as 2 feet of soil. In many places the surface soil has been completely removed. Bare fields of heavy soil which was so hard that it could not be cultivated with a lister responded readily to wind action.

With the organization of the Mansker demonstration project near Clayton, N. Mex., we found ourselves with an abundance of W. P. A. labor which must be put to work at once, hundreds of acres of hard bare fields controlled by absentee land owners, and nothing to work with but hand tools, a few trucks, and a borrowed plow.

The hard bare sandy-clay loam fields were an immediate and constant hazard. From one field soil blew out in such quantities that traffic was blocked on the principal north and south highway along the eastern side of the State.

It was decided that the W. P. A. labor could be employed and at the same time the forces of nature might help in repairing some of the damage. Thus was created the plan to transfer the sand drift conditions from the fence rows to terrace locations.

It was noted that these dunes occurred only where weeds lodged in the fences or were held fast in an otherwise bare field. Obviously the thing to do was to hold the soil in the field where it had lodged before it had traveled far enough to develop sufficient velocity to rise high into the air. A terrace could be

[1] Assistant engineer, Soil Conservation Service, Clayton, N. Mex.

This terrace was not completed when the dust storms struck but its performance demonstrated the soundness of its underlying theory.

formed without the creation of borrow pits; weeds which had heretofore been a detriment and a serious menace to fences could be put to beneficial use; no special machinery would be required and a farmer could protect his own land without the use of special equipment.

A Line of Tumble Weeds

Starting with these objects in view, the first weed barriers were built by merely placing a line of tumble weeds along on the contour and holding them in place with a few shovelfuls of dirt. The first wind storm demonstrated that the theory was correct. Light winds started dust clouds in the unprotected sections of the field, but the area protected by weed barriers remained quiet. Later, a heavy wind started dirt moving all over the field but it was observed that the soil close to the ground stopped in the weeds.

As we progressed, improvements were developed. In the present form, two heavy plow furrows are thrown together. This ridge is then covered with tumble weeds, and heavy dirt from a third furrow is used to hold the weeds in place. Soil transported by the heavy spring winds does the rest. Soils too light to be stabilized with lister furrows may be held in place in this manner.

The advantage of constructing terraces without borrow pits is obvious; however, a layer of heavier material over the surface is desirable but not absolutely necessary.

Terraces Stabilized

The binding medium which induced the formation of a terrace is found in the tumble weeds and if the terrace is to remain intact, it must be stabilized with a fibrous-rooted vegetative cover. Otherwise, with the rotting of the weeds, the same force which built the terrace will remove it. Little fear of losing the weeds may be felt, however, until after a rainfall sufficient to induce plant growth. Sudan grass, millet, or cane are recommended because of the dense vegetative cover and excellent root system. If at planting time the terrace has not developed sufficiently to permit the use of a drill, the seed should be broadcast and harrowed in.

It is true that bare fields should never exist, and conditions which permit wind-built terraces should never be permitted. But, during the past four or five years, fields have been planted, after careful preparation, which produced no cover crop—this due to the drought. Such fields became active wind erosion hazards. Fields which are listed or chiseled to present a rough cloddy surface soon become flat under the onslaught of high winds, and clods pulverize under the action of frost and a little moisture. A barrier above the surface of the ground is the only method of holding such a bare field, and it is under such conditions that weed terraces have value.

There is another advantage to these terraces beside serving as catchments for soil drift and barriers to run-off from rainfall. As may be observed in the illustrations, such structures reduce wind velocities near the ground sufficiently to permit plant seeds to lodge and grow.

From November until March or April there is little blowing hazard. During these 3 or 4 months the farmers can stabilize many acres and lay miles of terrace lines. With terraces costing from $40 to $65 per mile, the cost of laying the groundwork for weed terraces compares favorably, even if the farmer must employ help.

The popularity of this type of terrace has reached a point where farmers object to the removal of tumble weeds from their land, desiring that they be used upon their own property. This type of terrace barrier is now being employed on the Dalhart, Tex., project for stabilizing sand dunes. Farmers from other sections have visited this project and have gone home to stabilize their own fields. No equipment is necessary except a wagon, plow, shovel, and pitchfork.

Heavy Duty Vegetation

(*Continued from p. 42*)

Centipede grass [*Eremochloa ophiuroides* (Mumo) Hock] is being used very effectively in the lower part of the South. This grass does not produce rootstock and it can be eradicated by plowing. Centipede produces a very heavy, tough sod and can stand an unusual amount of heavy washing after being well established. It does not grow high enough to be cut for hay and produces only a small amount of viable seed. Usually it should be confined to primary or high-velocity channels, or to sod strips adjacent to pastures where grazing is practiced.

After determining the type of permanent vegetation, its actual establishment should take precedence in the agronomic program for the waterway. Although annuals will give quick returns, they may seriously interfere with the establishment of the vegetation that is to be relied upon for permanent protection.

Goforth's Stores Stand Idle—Her Streets Grow Weeds

By Harold G. Anthony [1]

Ghost town!

Deserted buildings; somber, weather beaten walls, decaying; lop-sided, dilapidated houses and store buildings; rust-pitted gin machinery strewn beneath a creaking, swaying tangle of sheet iron. Desolation.

That is the 1937 picture of what was, only a few short years ago, a thriving little community and trading center located in Hays County, in the southern extension of the rich Blackland section of Texas.

The history of this once prosperous village and its surrounding highly productive farm lands tells a poignant and tragic story of erosion.

Here is the story:

The rolling Blackland area was cleared of its native sward and mesquite trees following the Civil War, according to L. O. Miller, the only remaining resident of the immediate Goforth community.

"I guess this was the best farming area in the whole country", Mr. Miller says, "from the years around 1880 to 1906. Good crops were made. The deep, rich blackland soil produced from three-fourths to a bale of cotton per acre. The farmer who was fortunate enough to own or lease a tract of land in the Goforth area was almost assured at the outset that if he applied himself to the task of tilling his acres he was sure to prosper."

Land Values Increased

Mr. Miller continues his story by pointing out that more and more acres were cleared and land values rapidly increased as farmers from other areas, learning of the productive qualities of the land around Goforth, were willing to pay almost any price for acreage. Each succeeding crop year more steep land was cleared and put into cultivation the next cropping season. It was not long until fields began to gully and wash and yields declined. Little heed was given to such "warning signals", for it was a simple matter to abandon one field and clear up another.

By this time the village of Goforth was quite a thriving community. There was a post office and the general store known as the Goforth Supply Co. did an annual business of from $30,000 to $45,000. The store had six full-time clerks. There was a doctor and an apothecary who filled his prescriptions. The owners of the meat market and of the barber shop had

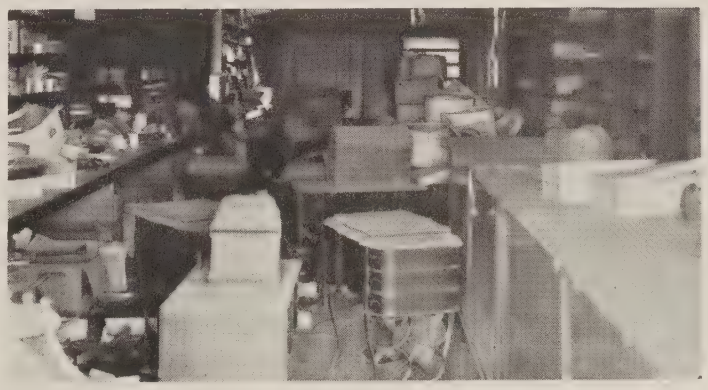
good bank accounts. Three men worked continuously in the blacksmith shop. From 2,000 to 2,500 bales of cotton were ginned annually at the big Goforth gin. A wagon freight line brought supplies from Austin.

Yields Decrease

The year 1900 was a big cotton year. Land values soared to $135, $150, even $200 an acre in some cases. Following this great year, however, there was a gradual, but very noticeable decline in the cotton yield. By 1907 cotton production on the acres swept of topsoil began to drop. Business fell off. In 1913 the entire countryside was practically flooded by torrential rains. Tons of the little remaining productive topsoil were washed from the fields; gaping gullies appeared. Production dropped, land loans went unpaid.

Some attempts were made at "sowing" the fields. Many farmers heeded the advice of Extension workers and constructed terraces. But erosion had done its work. By 1919 much of the land was abandoned. Farm families, giving up the losing fight, moved elsewhere. A complete crop failure in 1925, coupled with the devastation wrought by worms in the following year marked the virtual end of Goforth as a community and trading center. Families moved out of the community by the wholesale. Homes, farms were abandoned. No longer was it possible for any considerable number of people to make a livelihood from the eroded acres.

(*Continued on p. 50*)



[1] Administrative assistant, Soil Conservation Service, Fort Worth, Tex.

Before resectioning on an Arkansas State highway northeast of Monticello.

BRINGING EROSION CONTROL TO SOME HIGHWAYS

HIGHWAY erosion-control projects in region 4 provide information as to the adaptability, under the varying conditions found along highways, of the several erosion-control practices employed on agricultural lands. The primary purpose is not to improve any particular section of road but to provide basic ideas for work in areas of similar soil types and rainfall, and of corresponding construction seasons. If information is to be of practical value it must fit in with the planning of State highway engineers.

Demonstrations on Permanent Roads

Each highway erosion-control project embraces (1) changes and treatment of the road section, (2) type of cover to be established, and (3) a detailed plan of special control measures contemplated. Plans are made carefully and can be easily followed without previous technical experience. Any contemplated change in them must be submitted on a specified form and approved by the contracting parties. It has been the policy in Region 4 to establish areas only on sections of road that have permanent alignment and grade. Modern highways are constructed with wide shoulders and flat slopes, and the erosion-control measures must be established under similar conditions to prove beneficial and applicable.

The plan includes the modernization of the cross-section. This particular phase of the work is the basis of all roadside development. Hence, it has been the policy to improve the section to conform with the latest design before any erosion-control measures are installed. As a rule, the section can be easily improved by tractor and grader operations; however, if the excavation does not balance the fill, it is necessary to move this excess material to other sections where fill is needed.

The establishment of erosion-control measures on roads that do not have a modern section will not usually prove economical since such measures will be disturbed or destroyed when the section is modernized and coordinated with other phases of highway development.

The ditches are all designed for a desired velocity that will not scour the permanent cover. The ditch section is widened as the velocity increases beyond a safe point. In most instances, outside water has been brought on to the slopes by the use of solid sod.

The Common Outlet

The common outlet for terrace systems and highway drainage has been successfully demonstrated, and apparently this points the way to the solution of a problem that has long been a sore subject between the

After resectioning, same highway.

By Arnold Davis [1]

agricultural land owner and those charged with the responsibility of maintaining public roads. This common outlet has proved beneficial to both the land owner as being effective and inexpensive to maintain and to the road department as being permanent in character with maintenance and operation reduced to simple mowing.

Drop inlets have been used extensively to prevent erosion at the culverts and damage to agricultural lands above. Notched wing walls on the lower side of the culvert have been demonstrated favorably.

A ditch section on a fill, to prevent damage to agricultural land on the lower side of the road, is now being given a trial. These ditch sections carry the water to the culvert over a notch at the wing wall.

Severe Erosion in Cuts

It is apparent in this region that the most severe erosion occurs in cut sections. The fill sections as a rule have been controlled by native volunteer vegetation. It is believed by most highway engineers that this is due to the fact that the soil has been disturbed and has a high infiltration rate. In order to confirm this assumption, numerous cut sections are being plowed and cultivated.

Vegetation is the major erosion-control measure used. Since little is known as to the most economical methods of establishing vegetation on subsoil, numerous experiments are being tried out to determine the proper procedure in obtaining permanent cover.

To Establish Permanent Cover

The areas have been divided into sections of approximately 1,000 feet in length, depending upon the soil type, slope, and cut and fill sections. The various measures employed in establishing vegetation on the different sections are applications of the best-known practices, including numerous methods of transplanting permanent cover. The methods usually include those that will give immediate erosion control, such as solid sodding, and extend to the more economical practices where complete control can be expected in 1, 2, and 3 years. The amount of permanent cover transplanted has been gradually decreased, and nurse crops are now used to protect the areas until permanent cover is adequate. Various methods have been devised in transplanting sod, and, if successful, will be adaptable to the work of the highway departments.

Precipitation Recorded

Standard rain gages have been established near the areas in order to record any abnormal rainfall that might occur during and immediately after construction. This data is plotted on a yearly rainfall chart which shows precipitation in inches and duration in hours. The rainfall chart is referred to during routine inspections of the area.

[1] Associate agricultural engineer, Soil Conservation Service, Fort Worth, Tex.

One of the most important items is the reading and recording of field conditions. A form for this purpose has been worked out and found to be very satisfactory in correlating data to be used in formulating final recommendations. Precautionary measures have been taken to delay recommendations until the final analysis of the area is completed. Highway departments are eager for the information obtained from the established areas and in some cases are prone to jump to conclusions and to apply practices on large areas where they may not be effective.

Controlling erosion on agricultural land is the major problem of the Service and is given preference in all cases. Where areas have been established it has been possible to plan all work in such a manner as to prove economical to the operations on agricultural land. Reduction in the size of farm work crews results in a lower average cost than when the labor units are too large. Only labor not needed to establish measures on agricultural land is used on highway areas.

The Soil Conservation Service is offering a service to other Federal and State organizations whereby economical erosion-control methods may be devised for use in highway construction.

Goforth's Streets Grow Weeds

(*Continued from p. 47*)

The general store, the gin, the butcher shop were closed. There were no mortgages, but sufficient business was not available to make the enterprises profitable. Most of the fields were turned out.

Today great expanses of the land, barely able to support a sparse growth of weeds, stretch out across the rolling hills, sad evidence of the ravages of uncontrolled erosion, a monument to exploitation and agricultural "mining", resulting in a new kind of "ghost" town.

Launches Extension Program

(*Continued from p. 34*)

"Helping the farmer to adapt his general farm management into the soil conservation movement is a big job", Mr. Myer pointed out. "Just big enough", he said, "so that it will take the best efforts of both the Extension Service and the Soil Conservation Service working with many other agencies to do it." He cited instances where extension specialists reported that their work had doubled and trebled as a result of interest stimulated by Service projects.

Mr. Myer expressed pleasure over the fact that representatives of the two Services in the Ohio Valley were meeting around the conference table to analyze soil conservation problems and attack them on a broad scale. Of the individual demonstration farms, he said, "There will be more of them, thus bringing soil conservation methods and practices closer to more farmers."

Others who attended the Dayton conference and took part in the discussions were C. B. Manifold, chief of operations of the Service, Washington, D. C.; W. L. Baynes, Indiana State coordinator; D. T. Herman, Ohio State coordinator; E. C. Sackrider, Michigan State coordinator; W. M. Hardy, Tennessee State coordinator; R. O. Cole and E. P. Reed, extension soil conservationists in Indiana and Ohio; George Roberts, assistant dean of agriculture, University of Kentucky; and H. W. Gilbertson, Agricultural Extension Service, Washington, D. C.

SOILS AFFECTED BY WIND EROSION

Samples of cropped, virgin, subsurface, and drifted soils were collected in and near the Oklahoma Panhandle during the fall and winter of 1935–36. Mechanical analyses were made in order to determine the percentage of sand, silt, and clay in each sample; and, also, experiments were carried out to discover total nitrogen and organic matter content. Resulting data show that the hummocks and drifts in the high plains soils have lost 37.8 percent of their silt and clay and have increased 29.3 percent in sand over the adjacent virgin surface soils. The same soils have decreased 24.5 percent in organic matter and 28 percent in total nitrogen when the drifts are compared with the adjacent virgin surface soils. Cropping and wind erosion combined have decreased the cultivatable soil 15 percent in total nitrogen.

Conservation Farming Practices and Flood Control is the title of the new miscellaneous publication by Dr. Bennett which describes the farmers' part in dealing with flood waters in small and large streams. Protective soil-building crop rotations, contour strip cropping, contour tillage, soil- and water-saving terraces, check dams, and grassed waterways are outlined and recommended as some of the practices which the farmer may employ on his land to check the force of run-off and at the same time build up the soil.

NEXT MONTH.—The September issue will be devoted to vegetation's important part in the program of the Soil Conservation Service.

BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

SOIL EROSION AND ITS CONTROL. By Quincy Claude Ayres. New York and London. 1936.

This book, written by an agricultural engineer, can go right into the field and be used for practical results by engineers and field workers who are on the fighting front where the erosion problem exists. It is an eminently workable and comprehensive treatment of the subject, and its readers are given definite instructions on how to put into practice those soil-erosion remedies which have proved themselves effective in field trials. The significance and extent of erosion in the United States and factors affecting its acceleration are briefed in the first 38 pages, from which point the author proceeds to his detailed directions on the desgin and construction of terraces, diversion ditches and soil-saving dams, strip farming and the planting and care of trees, grasses, shrubs, and vines. Descriptions of control methods are complete enough to enable the careful reader to put the remedies into actual practice.

In launching into the subject of control methods, Mr. Ayres states: "The first step in any rational solution is to restrict open cultivated land to slopes and conditions where erosion can be held within predetermined limits." The statement is further qualified as meaning that there are certain slopes suited to agricultural crops, others to permanent pastures, and still others to forests and that the border zone between the three uses is one of considerable width and flexibility to allow for local variations.

In a chapter dealing with ways and means of keeping erosion under control on slopes suitable for cultivated crops some exceptionally well-chosen data is given to point out the necessity for crop rotations, contour farming and strip cropping. The Texas, Missouri, and Wisconsin strip-cropping practices are outlined in detail, particularly as to width and arrangement of strips both with and without terraces. The rational equation, $Q = CIA$, by Mr. Ramser, is used in directions for making the quantitative determination of critical run-off which is necessary to capacity and design of erosion-control structures, and from this the book passes into a long and detailed discussion of terraces. In fact, the greater part of the volume is devoted to terraces and their construction and maintenance.

Every detail of locating, designing, and constructing the broad-base, shallow-channel type terrace is given, with special emphasis on grade, spacing and outlets, and computation of capacity. Terracing equipment receives considerable space in the book, including practically everything from the "turret" type farm level used in staking out terrace lines to tractor-power terracers and graders. Of especial importance is that part of the section dealing with terraces which presents directions for care of terraces during the first year and for plowing and planting land that has been subjected to terrace treatment.

In emphasizing the importance of proper terrace outlets Mr. Ayres devotes a complete chapter to this phase of the structures. The Soil Conservation Service work at Bethany, Mo., is shown in chart form and noted as representing a well-thought-out arrangement from the conservation point of view, of terrace outlets and plantings. "The ideal outlet", the author states, "is a dense growth of underbrush and timber on a moderate slope with a thick mulch of leaves and debris to spread out and partially absorb the water discharged from the terrace channels." A permanent pasture of tough sod is also satisfactory. But if neither the pasture nor the underbrush with timber are available, the recourse is a constructed outlet in the form of a ditch or draw properly placed and graded to prevent erosion. "Neglect of such protection in the past has been responsible for more terrace failures than any other single cause," writes Mr. Ayres. And, "It is a mistake to place too much dependence on a natural outlet simply because it is natural." Vegetative control is advocated in outlet channels where slope is not above 12 percent, and species and planting methods are given for obtaining permanent sod.

Three chapters dealing with control of gullies, temporary and semipermanent check dams, and permanent or soil-saving dams, describe practically all types of overfall protection devices. The pages comprising these chapters are well supplied with detailed charts, tables and photographs, and the text is exceptionally complete in descriptive detail.

As Mr. Ayres points out at the head of his chapter on special uses of vegetation "the ultimate purpose of building most check dams is to make possible the restoration of natural control through the growth of vegetation." Somewhat briefly (for the author is not an agronomist but an engineer) Mr. Ayres discusses plantings of trees, shrubs, grass, and vines which have proved themselves valuable erosion-control mediums. The special emphasis is upon plantings for control of gullies and stream bank erosion and protection of structures. A final chapter on soil conservation and land use outlines the experiments under way at the Bethany, Mo., soil erosion experiment station when the book was prepared for publication. Herein is included also a discussion of coordination of physical factors and some suggestions for cropping and erosion-control practices. The appendix is devoted to simple methods of calculating land areas, and a partial list of soil-conserving, semi-soil-conserving and soil-depleting crops. The bibliography at the end of the book is extensive, containing more than two hundred references on conservation and related subjects.

METHODOLOGY IN SOIL CONSERVATION AND AGRICULTURAL ADJUSTMENT RESEARCH. By Rainer Schickele, Ames, Iowa. March 1937.

In this bulletin is to be found a description of the procedure and preliminary findings of the research project designed and carried out in the effort to determine suitable land-use patterns and crop and livestock systems which if adopted would conserve soil resources and at the same time provide a secure foundation for economic returns and cultural environment of farm life. The emphasis is on "methodology of indicating and analyzing factual material rather than on the descriptive presentation of the facts themselves."

A brief historical sketch of research projects in agricultural adjustment is given, showing that the study plan had its inception in March of 1934 when the Iowa Agricultural Experiment Station launched a cooperative study, with the Production Planning Section of the A. A. A., to suggest desirable crop systems and sound farm practices for Iowa. Since subsequent studies were based on the Iowa project, the author has seen fit to set forth the problems, methods, and results encountered in the investigation of present farming characteristics in the Corn Belt in general and Iowa in particular. Present land-use patterns and crop systems are discussed with regard to feed unit productivity of crops and pastures, commercial movements of feed grains, and animal units and livestock systems.

The problem of soil erosion and depletion in Iowa is discussed at some length. In the interest of its soil resources the State is divided into three soil conservation districts. The first district comprises the southern Iowa loess area where there is severe

gully and sheet erosion, with shallow surface soil and infertile subsoil. Immediate readjustment of farming and crop systems is recommended for this area with intensive demonstration work in erosion-control measures. For the districts of the second and third orders, including the Mississippi and Missouri loess areas, with moderate to slight gullying and sheet erosion, it is suggested that adjustment be accomplished through education and reforms in tenure and credit systems.

Following the outline of soil conditions throughout the various districts, the author presents a rather extensive discussion of the problems involved in adjusting crop rotations and farming types to soil conditions. The determinations of crop systems in the study "* * * rested largely upon the general characteristics of the major soil types and the general conservational properties of major rotations regarding their effects on erosion and nitrogen and organic matter content of the soil."

The appendix contains sample work sheets, farming system criteria, and statistical maps used in the study.

STABILIZATION OF ROADSIDE BANKS

(*Continued from p. 40*)

The following statement gives an idea of the approximate amounts of materials and labor used and their costs:

Cost of seed (214 pounds at 20¢)	$42.80
Cost (approximate) of materials in compost	57.00
Cost (approximate) of labor in preparing compost	70.00
Total cost of seed and compost	169.80
Total cost of technical supervision and labor, exclusive of labor in preparing compost	475.84
Grand total, materials and labor	645.64

(Note.—The cost of transporting materials is not included in this summary. The area of road work seeded was 85,300 square feet, and the cost approximated $7.57 per 1,000 square feet.)

Results

The short duration of time since the inception of this work, and the variable climatic factors affecting its success, do not permit of definite conclusions at this time. The establishment of a stand of vegetation sufficiently dense to withstand erosion was the main criterion used in evaluating the success of the work. Since the work was carried out in a region which has been settled for a long period of time, erosion-control practices had to be installed under the existing conditions. Many of the road cuts show slopes steeper than 60 percent. A reduction of the slope is often very difficult since it cannot be made unless either the road width is reduced or the top of the bank is cut away, in which latter event existing fence lines may be undermined. However, frequent observations made at various times since this work was started seem to justify the following statements:

1. Seeding work was successful where the slope of the banks approximated 60 percent or less, and where the banks were properly mulched. Seeding of banks with a slope of over 60 percent in general was not successful.
2. Heavy rains following the seeding program caused poor results on the unmulched areas. In nearly all places the mulched areas on slopes of 60 percent or less gave ample protection against heavy rainfall.
3. In periods of very hot and dry weather such as were experienced in this work, results on southern and southwestern exposures were not nearly as successful as on other exposures.
4. In spite of the unfavorable weather conditions which followed this seeding program, the work was successful on at least three-fourths of the area seeded.

Withstanding a Test

(*Continued from p. 44*)

which had been built across a gully 25 feet deep draining 90 acres of cultivated land.

Wherever there was a good vegetative cover, such as bluegrass, legumes, and winter wheat, the result was the same—very slight erosion damage regardless of the run-off. An example of the value of wheat for winter cover is the field shown on page 44. This field was drilled on the contour between corn rows last fall and now is providing good pasture and excellent protection against erosion on a 7-percent slope. The 4½-inch rain carried very little soil from this field.

In contrast, those fields which had no protection showed sheet erosion and gullying. A field that had been drilled to oats up and down the slope had lost hundreds of tons of soil from the one rain.

U. S. GOVERNMENT PRINTING OFFICE: 1937

Variety of New Publications of Wide Usefulness in Field

For REFERENCE
Compiled by Mrs. ETTA G. ROGERS, Publications Unit

Field offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

Soil Conservation Service

Design and Construction of the Drop Inlet Soil-Saving Dam. SCS-EP-14. mm. June 1937.

Office of Information U. S. Department of Agriculture

Strip Cropping for Soil Conservation. Farmers' Bulletin 1776. June 1937.

Comparison of Various Chemical Quick Tests on Different Soils. Miscellaneous Publication 259. May 1937.

A Graphic Summary of Physical Features and Land Utilization in the United States. Miscellaneous Publication 260. May 1937.

Drought Survival of Native Grass Species in the Central and Southern Great Plains, 1935. Technical Bulletin 549. March 1937.

Comparison of Feeds for Wintering Steers in the Northern Great Plains. Technical Bulletin 565. May 1937.

Soil Erosion and Stream Flow on Range and Forest Lands of the Upper Rio Grande Watershed in Relation to Land Resources and Human Welfare. Technical Bulletin 567. May 1937.

Irrigated Crop Rotations at the Huntley (Mont.) Field Station, 1912-35. Technical Bulletin 571. June 1937.

Agricultural Experiment Stations

An All-year Pasture System for Missouri. Circular 193. Agricultural Experiment Station, Columbia, Mo. February 1937.

The Calcium and Phosphorus Contents of Important New Mexico Range Forages. Technical Bulletin 246. Agricultural Experiment Station, State College, N. Mex. April 1937.

Conservation of Land and Water Resources of Nebraska. Bulletin 14. Conservation Department, Conservation and Survey Division, University of Nebraska, Lincoln, Nebr. December 1936.

Conservation Program on Fruit and Vegetable Farms. Extension Circular 200. Extension Service, University of New Hampshire, Durham, N. H. February 1937.

Crop Rotations. Part I: Effect of Crop Rotations on Succeeding Crops. Part II: Effect of Crop Rotations on Productivity of the Soil. Bulletin 344. Agricultural Experiment Station, Pullman, Wash. March 1937.

An Economic Study of Livestock Farms in Maryland. Bulletin 406. Agricultural Experiment Station, College Park, Md. November 1936.

Effect of Electric Current on Certain Crop Plants. Research Bulletin 210. Agricultural Experiment Station, Ames, Iowa. March 1937.

Factors Affecting the Economic Self-Sufficiency of the Middle Rio Grande Conservancy District. Bulletin 247. Agricultural Experiment Station, State College, N. Mex. April 1937.

Farm Tenure in Iowa. III. The National Farm Institute Symposium on Land Tenure. Bulletin 357. Agricultural Experiment Station, Ames, Iowa. April 1937.

Fertilizers for Cotton on the Coastal Plain Soils of Louisiana. Bulletin 285. Agricultural Experiment Station, Baton Rouge, La. April 1937.

Fertilizers for Cotton on the Prairie Soils of Southwest Louisiana. Bulletin 286. Agricultural Experiment Station, Baton Rouge, La. April 1937.

Fertilizers for Cotton on the Red and Mississippi River Alluvial Soils of Louisiana. Bulletin 284. Agricultural Experiment Station, Baton Rouge, La. April 1937.

Handbook of Statistics: For Use of County Agents and Others Interested in the Land Problems of Oregon. Station Circular of Information No. 169. Division of Agricultural Economics, Oregon State College, Corvallis, Oreg. January 1937.

Land Utilization and Classification in New York, and Its Relation to Roads, Electricity, and Reforestation. Bulletin 372. Cornell University, Ithaca, N. Y. March 1937.

Methods of Conserving Michigan Muck Soils. Reprint from Quarterly Bulletin, Volume 19, No. 3. Agricultural Experiment Station, East Lansing, Mich. February 1937.

Permanent Pasture Studies. Bulletin 308. Agricultural Experiment Station, Clemson, S. C. April 1937.

Production Requirements and Costs on Irrigated Farms in Montana. Bulletin 338. Agricultural Experiment Station, Bozeman, Mont. April 1937.

The Relation of Nitrogen and Soil Moisture to Growth and Fruitfulness of Apple Trees Under Different Systems of Soil Management. Bulletin 414. Agricultural Experiment Station, Lafayette, Ind. November 1936.

The Relation of Rainfall to the Development of Late Blight of Irish Potatoes in the Coastal Section of South Carolina. Circular 57. Agricultural Experiment Station, Clemson, S. C. April 1937.

The Significance of Land Slope. Volume 13, Nos. 7 and 8, Agricultural Education. School of Vocational Education, Clemson Agricultural College, Clemson, S. C. March and April 1937.

Small Grain and Rye Grass for Winter Pasture. Bulletin 539. Agricultural Experiment Station, College Station, Tex. April 1937.

Soils in Relation to Fruit Growing in New York: Part X, Susceptibility of Various New York Orchard Soils to Reduction Upon Water-Logging. Bulletin 667. Agricultural Experiment Station, Ithaca, N. Y. March 1937.

Some 1936 Improvements on Georgia Farms. Agricultural Extension Service, University of Georgia, College of Agriculture, Athens, Ga. Undated.

Types of Farming in Utah. Bulletin 275. Agricultural Experiment Station, Logan, Utah. November 1936.

Miscellaneous

Second Annual Report of Progress: New Jersey State Planning Board, 1936. New Jersey State Planning Board, Trenton, N. J. 1937. $1.00.

FOR CONVENIENCE IN SUBSCRIBING TO SOIL CONSERVATION

Superintendent of Documents, Government Printing Office, Washington, D. C.

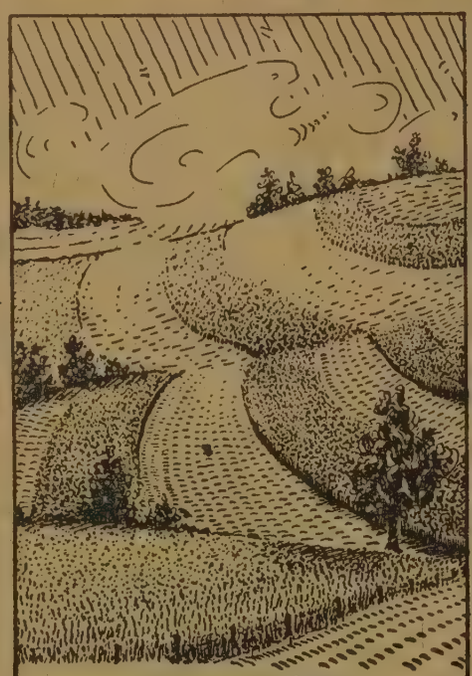
Enclosed find $1 (foreign, $1.40), for which please enter my subscription to SOIL CONSERVATION for one year.

.....

Name (*write plainly*) Address

Do not send postage stamps

SOME STRIP CROPPING POINTERS



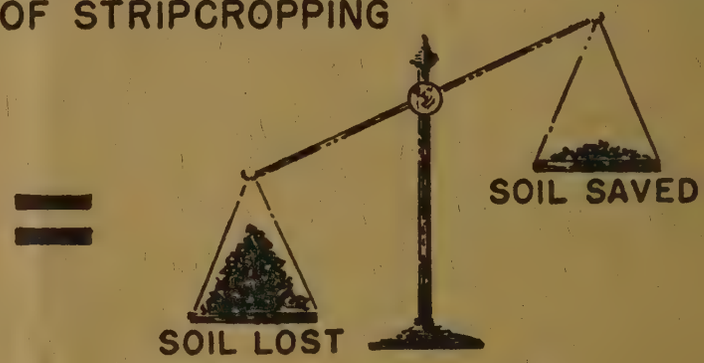
CONTOUR

FIELD

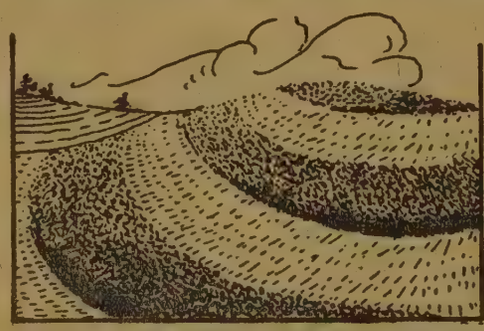
WIND

3 TYPES OF STRIPCROPPING

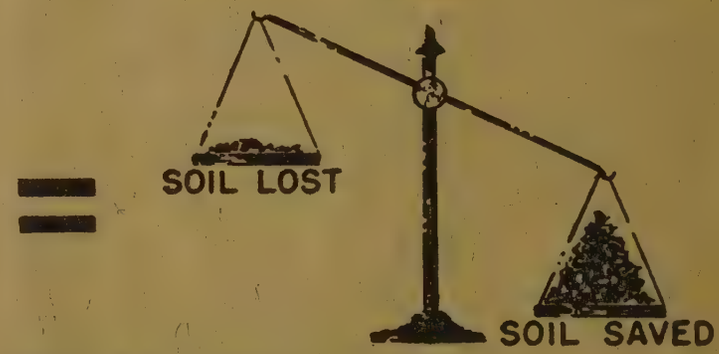
HAPHAZARDLY PLOWED FIELD



CONTOUR-FURROWED FIELD



CONTOUR-TILLED AND STRIP-CROPPED FIELD



Editor's Note.—The above presentation was suggested by Farmers' Bulletin No. 1776, Strip Cropping for Soil Conservation, a practical publication fresh from the press. This bulletin supersedes Leaflet No. 85, Strip Cropping to Prevent Erosion, and was prepared for the Department of Agriculture by Walter V. Kell and Grover F. Brown of the Soil Conservation Service.

So 35
LIBRARY
SEP 24 1937

SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE · WASHINGTON

SEPTEMBER
1937

Vegetation for Soil Conservation

Contents

	Page
A Foreword to This Issue: *By the Chief of the Soil Conservation Service*	53
Ecological Principles: *By W. C. Lowdermilk*	54
Flood Control: *By A. L. Patrick*	55
Trees: *By E. V. Jotter*	57
Vegetation Cuts Costs: *By Barrington King*	59
Engineering Phase: *By T. B. Chambers*	60
Slope Usage: *By S. B. Detwiler*	64
Propagation: *By F. J. Crider*	68
Grass Seed: *By M. M. Hoover*	72
Wildlife Management: *By William R. Van Dersal*	73
A Promising New Cedar for Erosion Control: *By Charles F. Swingle*	75
New Life for the Old Farm: *By Walter V. Kell*	79
Farm Planning: *By H. C. Diener*	82
Book Reviews and Abstracts: *By Phoebe O'Neall Faris*	84
For Reference: *Compiled by Mrs. Etta G. Rogers*	Opposite 84

SOIL CONSERVATION is issued monthly by SOIL CONSERVATION SERVICE of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. SOIL CONSERVATION seeks to supply to workers and cooperators of the Department of Agriculture engaged in soil conservation activities information of especial help to them in the performance of their duties, and is issued to them free by law. Others may obtain copies from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of $1.00 per year, domestic; $1.40 per year, foreign. Postage stamps will not be accepted in payment.

WELLINGTON BRINK
EDITOR

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

H. H. BENNETT
Chief, Soil Conservation Service

VOL. III • NO. 3

SEPTEMBER • 1937

ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON

THE practical soil conservationist nowadays talks with a stem of timothy hay in his mouth.

HE KNOWS that grass, shrubs, vines, trees, roots, ground litter of leaves and stems, crop residues and organic matter accumulated within the body of the soil are Nature's own guardians of the land and effective weapons of land defense at the service of every farmer. If a farmer is to lick erosion, he must cloak his fields or portions of them with vegetation and work into his soil spongy, absorptive vegetable matter to bind the soil and to hold needed water. That single statement just about sums up the challenge and the answer to accelerated soil erosion on millions of acres.

THE Soil Conservation Service has an immediate and continued concern with the utilization of materials and weapons at hand, with the reestablishment of suitable cover on denuded areas, with the discovery and development of plants of superior erosion-resisting and economic qualities, with practices that will add to the value of existing pastures, and with cultivation for profits rather than losses.

ROTATION is no new discovery; it has been preached and practiced by generations of intelligent husbandmen. Field production, pasture and range management, fences, woodlots, stock ponds—chapters old and shelf-worn—have merely been revised or given accent in the light of accruing necessity. Today, for example, we curve the fields and the rows, plant in strips, aim at cloddy cultivation, test buffer strips and meadow strips, slow rather than hasten run-off, measure the slopes and appraise the erodibility of soils. We find it just as scientific to be practical as it is practical to be scientific.

A READING of the contents of this issue of SOIL CONSERVATION reveals how fundamental is vegetation in the program of the Service. Erosion engineering itself leans far more heavily on vegetative materials than on the more spectacular masonry. It recognizes that land values and special land conditions largely govern the use of mechanical structures, and that the farmer's skill and convenience give preference to sod, shrubs, vines, and trees.

THIS, of course, is not all of the program that must be applied to thousands of farms—to most farms. It is, nevertheless, a tremendously important part of the integrated plan adopted by the Soil Conservation Service to control erosion and conserve water. This plan calls for the treatment of the different kinds of land that make up a field or a farm, according to the needs and adaptabilities of each field or parcel of land. We cannot plant all of our cotton fields to grass, or all of our wheat fields to trees. Accordingly, it is necessary to compromise with Nature's plan to some extent; and, in addition to making use of vegetative measures of control, we must plow on the contour, build diversion ditches, terraces, dikes and dams where they are needed or where they assist other control measures required to meet the complex conditions existing over the agricultural domain of the Nation.

AS I TRAVEL agricultural America, I am gratified at the comparative absence of grandiose ideas on how to conserve soil and water. On projects, on cooperating farms, on adjacent farms, the trend is toward grass, toward soil-building crops, toward contour cultivation, toward a scheme of soil defense and water conservation that may be embraced readily by the average producer and at the same time permit him to live off the land.

A Foreword to This Issue

By the Chief of the Soil Conservation Service

ECOLOGICAL PRINCIPLES

W·C·Lowdermilk[1] offers basic approach to sustained land use

THE research program is directed toward determining the character of soil erosion and the methods of integrated action for its control. The steps include: comprehensive Nation-wide land-use planning; general application of emergency measures to arrest the rate of soil-resource loss, including structural work and quick revegetation; permanent soil-conserving agriculture based upon the principles of applied ecology.

The ecological approach is based upon realization that accelerated soil wastage does not occur under undisturbed conditions, and that natural processes in the past have served to develop a high order of soil fertility. We have seen the havoc wrought by man in changing natural conditions without due precautions against the accelerated action of wind and water. We therefore must aim at the use of Nature's constructive methods both in overcoming the destructive forces and in providing our needs from the soil. This calls for integrated land-use planning and management, and appears to be leading toward a new type of applied science which, lacking a better name, may be termed "vegetative engineering" or "ecological engineering."

The fundamental considerations in the ecological approach to erosion control are: (*a*) To restrict cultivation as far as practicable to flat lands and gentler sloping lands; (*b*) to conserve fertility of soil under tillage by technically adequate cultural methods; (*c*) to supplement the products of tillage by products that may be profitably produced by permanent vegetative covers managed and directed through controlled ecological successions.

The soundness and wisdom of the ecological approach to sustained land use is found in those countries where the pressing needs of human populations, combined with technological progress, have brought about more intelligent methods of land management. The Japanese have reclaimed the formerly barren slopes of their mountain sides in an effort to attain economic freedom through requisite wood products. Their method has been remarkably simplified through study and experience. It is based upon planting a few species of grasses and shrubs to form the initial temporary cover which is rapidly changed over into a permanently integrated forest cover.

In the United States, except for advances made in applied forestry science, we have made use of the ecological measures chiefly by leaving to nature the process of rebuilding soils after they have been depleted of fertility and eroded to such an extent that tillage became unprofitable. As the development of our country moved westward, it was easier to clear new land than to repair worn-out soils. Today we must regret some of our extravagance, revise our system of land use and rebuild many of our soils in accordance with nature's soil-conserving principles.

Present research deals chiefly with the character of accelerated erosion and with the economically feasible emergency steps that can be employed quickly to arrest damage. This is necessary in order to set the stage for the permanent methods of erosion-control farming and ecological engineering that must follow.

The heart of this principle lies in the parallel courses of water conservation and regulation on the one hand; and in better managed vegetation on the other. Over much of the area requiring soil protection there is normally a shortage of water during the growth season, this, in turn, lessens the opportunity for producing an abundance of vegetative cover. The hazards of wind and water erosion have accordingly a tendency to occur alternately.

Present efforts deal with structures, processes, and treatments calculated to regulate and conserve water to the best advantage of plant growth. Contour structures and devices to prevent run-off, vegetative and mechanical means for utilizing the porosity of the soil, and various forms of strip cropping are all useful in regulating run-off of surface water and in facilitating water absorption by the soil. Where there is an excess of water during certain seasons, our effort is to hold it where it falls for future needs. The water problems in their many aspects, therefore, constitute an important part of the integrated land management that is basic to a permanent agriculture.

The other primary factor in this broad picture is plant life itself. Past effort in erosion control by vegetative means often failed because it was based

(*Continued on p. 59*)

[1] Chief, Soil Conservation Research, Soil Conservation Service, Washington, D. C.

FLOOD CONTROL

Supplemental value of vegetative cover stressed

by A·L·Patrick[1]

EXPERIMENTS of recent years have demonstrated the value of vegetative cover in reducing run-off and the part this plays in a flood-control program. Today its use is receiving more consideration by flood-control workers, including engineers, foresters, agronomists, and others. It is not to be inferred that vegetative cover alone is sufficient to eliminate floods. It must be supplemental to other practices applied on the land, as well as to the various types of flood-control structures commonly used along trunk streams. The real value of vegetative cover as a flood-control measure is brought about by increased infiltration of water into the soil and a greater utilization of the soil's storage capacity.

The ways in which vegetation assists infiltration are many and varied. Among the most important should be listed the improvement of structure, or particle arrangement, in fine-textured soils. Small live roots and finely decomposed organic material help to bring about a rearrangement of these particles so that they gather together in small clumps or little aggregates between which the openings are fairly large. In such a condition, clays and loams tend to act much like sands in their ability to absorb water rapidly Openings made by worms, insects, and decayed roots form channels down which water runs by gravitational action very rapidly.

It is essential, if water is to percolate into the soil at the maximum rate, that all of the natural soil openings be kept open. In reality, they constitute small channels running to considerable depths below the surface. None of the soil openings are very large in diameter, but they make up in quantity for the lack of size. They are easily clogged by muddy water, and when clogged rainwater runs off and over the surface instead of into the soil. Soil protected by litter (leaves, twigs, humus, etc.) or dense sods contain openings which are seldom clogged. The raindrop does not stir up fine particles to be washed into the minute channels; instead it is divided into a fine spray of clear water which percolates rapidly into the soil. The total or partial destruction of these soil protective materials by improper management of forest or grass lands, or by cultivation, results in flash run-off and loss of soil by erosion.

[1] Chief, Watershed and Conservation Survey Division, Soil Conservation Service, Washington, D. C.

The soil mass is divided into solid matter and pore space. Pore space is the portion of a volume of soil which is occupied by water or air. Largely because of the tendency to granulate, fine soils have a large amount of pore space; and the coarser the soil, the smaller is the amount of internal space. The following table taken from King illustrates the extent of pore space in relation to soil texture.

	Percentage of pore space
Sandy soil	32.49
Loam	34.49
Heavy loam	44.15
Loamy clay soil	45.32
Clayey loam	47.10
Clay	48.00
Very fine clay	52.94

The above table shows that the space in soil which may be occupied by water varies from one-third to over one-half of the actual volume. Middleton has interpreted pore space in terms of inches of rainfall down to a depth of 3 feet for three common midwestern soils.

Porosity of 3 representative soils [1]

Soil type and location	Depth of sample	Porosity	Calculated maximum possible water storage of surface 3 feet of soil [2]
	Inches	*Percent by volume*	*Inches*
Vernon fine sandy loam, Guthrie, Okla.	(3)	43.3	14.4
	2½	41.5	
	8	41.7	
	22	39.4	
	38	40.2	
Muskingum silt loam, Zanesville, Ohio.	(3)	48.1	16.2
	3½	45.1	
	9	47.8	
	17	45.5	
	32	31.3	
	54	32.7	
Marshall silt loam, Clarinda, Iowa	(3)	55.9	20.7
	6½	56.4	
	18½	60.3	
	32½	58.7	

[1] Middleton, H. E., Slater, C. S., and Byers, H. G. The Physical and Chemical Characteristics of the Soils from the Erosion Experiment Stations—Second Report. U. S. Dept. Agr. Tech. Bull. 430, 1934.

[2] The figures under this heading were calculated by Dr. Middleton but not included in the publication.

[3] Surface.

Newly contour-furrowed pasture, Beaver Run (Pa.) project.

The same furrowed field following a rain.

Assuming that this internal space continues at about this same ratio to solid matter as depth increases until solid rock is encountered, then one will begin to visualize the vast water-storage capacity that exists in the soil—a capacity so great as to be capable of accommodating all the water that falls for a considerable period of time. At Zanesville, Ohio, last January, after the storm which produced the floods on the Ohio River watershed had been in progress several days, the soil gave every appearance of being saturated. Nevertheless, soil covered with good grass sod continued to absorb water at the end of the storm period at about the same rate as at the beginning of the storm. This indicates that the soil was not saturated, but rather that there was a continuous downward movement of water into the lower soil strata and eventually into the ground water supply.

A potentially large soil reservoir exists; yet water running off the surface of the land carries with it rich life-sustaining topsoil, resulting in swollen streams, shoaling of channels, floods, and destruction. The existence of an unsaturated internal water reservoir does not imply that it will be utilized. The problem facing those interested in watershed retardation of precipitation is how to make the greatest possible use of this potential storage capacity.

It is true that rain water will run off sloping land covered with dense sods or virgin forests if the ground is frozen, if the rock is close to the surface, or if an extremely indurated layer occurs close to the surface. On the other hand, ground covered with dense sods or deep leaf litter are less likely to be frozen than is unprotected land. Hardpan layers are not commonly found on sloping land, and bed rock seldom occurs over extensive areas close to the surface. Many experiments show that grass and trees are Nature's means of protecting soil from washing and excessive run-off. Federal experiment stations are at present carrying on approximately 500 individual field and laboratory studies involving the effectiveness of vegetative cover and land use in reducing run-off and erosion. Many of these studies involve precise measurement of rate and quantity of precipitation, and the resulting run-off and erosion in carefully controlled areas varies from small plats of watersheds up to 30,000 acres. Data are being accumulated from every

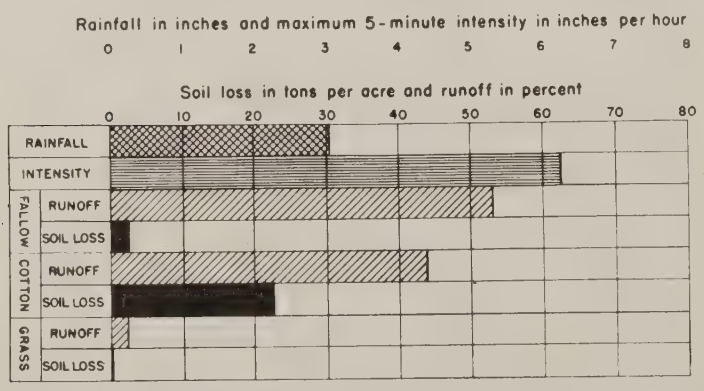


Figure 1.—The effect of plant cover on run-off and soil loss from rain of high intensity, Guthrie, Okla., May 30, 1932. Slope, 7.7 percent.

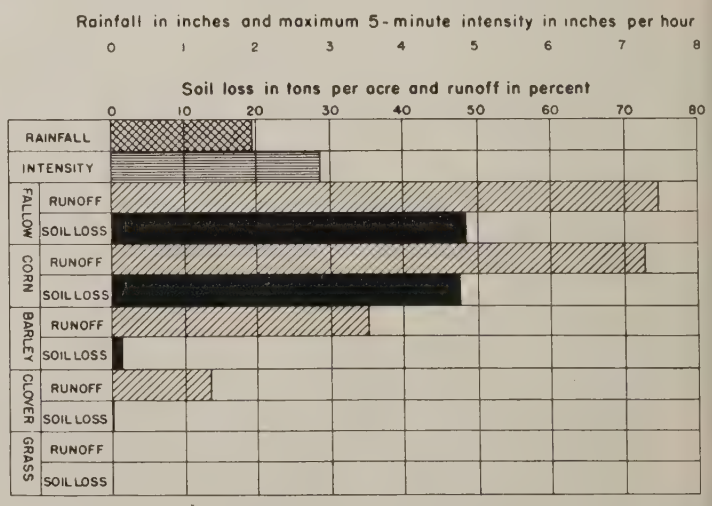


Figure 2.—The effect of plant cover on run-off and soil loss from rain of high intensity, La Crosse, Wis., July 5, 1935. Slope, 16 percent.

rain or snowfall on each of these plats and watersheds. An average of approximately 9,000 measurements all together are being made each year. Figures 1 and 2 present a comparison between vegetative cover and no cover.

Every practice which the Soil Conservation Service is demonstrating so thoroughly in all parts of the country as water-erosion control measures are also flood-control measures. If water is made to creep into instead of to run off the land, the great soil reservoir will have an opportunity to perform its share in the control of floods. This will necessitate the treatment of all land in accordance with its need and adaptability. Cultivation can be carried on where land is not too sloping, but the use of inexpensive practices such as strip cropping, terracing, contour furrowing, etc., will be required.

The recognition by Congress that the Department of Agriculture has a place in flood-control planning and operations is a real step forward which, in years to come, land owners of the Nation should realize to their advantage. At this particular time, the Department is in a better position than ever before to shoulder this great responsibility. The action programs of the Forest Service and the Soil Conservation Service, as well as those of various other departmental agencies, blend together in such a manner as to complement each other, and together they will make an adequate supplement to existing flood-control programs. In the planning phases the Bureau of Agricultural Economics will have a very definite place, and other agencies will likewise make important contributions. The first stage of what appears to be a huge task has been reached, and a small appropriation has been made for planning phases. There will be plenty for everyone to do. Perfect synchronization of all phases of the entire program by Federal and State agencies is absolutely essential. If present plans are carried through this will be assured.

Proper land use is a prerequisite of any adequate flood-control program. Here a West Virginia farmer makes maximum use of vegetation by using timber on his steepest, most erosible areas; grass and hay on intermediate slopes, and a good strip-cropping system on the less vulnerable slopes. Such a plan reduces soil and water losses and makes possible a greater income for the labor expended.

TREES

E·V·Jotter[1] describes the place of farm woodlands in the Service program

ONE spring does not make a river and one farm woods has little effect in flood control, but a little patch of woods here, a larger one on another farm, parts of thousands and thousands of agricultural units, make up the striking total of 185,000,000 acres of forest cover. They form more than 17 percent of the total farm area of the United States. They include within their boundaries almost a third of the entire forest area of the Nation. They are located within the more densely populated regions where their effect on the conservation of soil and moisture and the control of floods has immediate as well as far-reaching influence upon the physical, economic, and social structures of our country.

In the New England States the farm woods total almost one-half of the agricultural lands and average 27 acres per farm. The States within the drainage basin of the Ohio, though most highly organized for intensive agricultural crop production, have almost one-sixth of the farm area in woods with from 10 to 15 acres on each farm. Down South, in the States of South Carolina, Georgia, Florida, Alabama, and Mississippi, over two-fifths of the farm land is in woods with an average area per farm of 27 acres.

The methods by which properly managed woods affect run-off are well recognized. The tree canopy and the litter on the forest floor increase the absorption and infiltration of water. Studies made at the time of the Ohio floods showed that in cultivated fields there was much more water at the surface than at a depth of 2 or 3 feet, indicating that the full capacity of water had not been taken up. Nearby forest soils, however, held more water at the same depth than the surface soils of the cultivated fields.

[1] Senior forester, Section of Woodland Management, Soil Conservation Service, Washington, D. C.

Six million farmers own 185,000,000 acres of woods. Good management of these woods is an important part of the flood-control job.

Records taken during a heavy and prolonged rain near Ithaca, N. Y., showed an 88-percent run-off from 14-percent slopes on lands cleared of woods, whereas on adjoining forest and grass areas, with 27-percent slopes, less than one-half of 1 percent was lost through run-off.

Some studies on run-off of flood-producing rain storms of limited duration, made in the Ohio Valley, showed that seven times as much water ran off the cultivated fields as from the forested areas.

These examples of effect on run-off, when multiplied by the vast areas of farmwoods in the eastern United States totalling 147,000,000 acres, or almost a sixth of the total land area, would indicate that they are in the aggregate outstandingly important as a means of flood control through vegetative cover, particularly because they are usually on the steeper parts of the farm.

But what is the condition of the average farmwoods? Grazing stock destroys the vegetation, disturbs the protective forest litter, and impacts the soil. Recurrent fires remove the litter and affect seriously, if they do not finally annihilate, the forest. The present farm woods is a far cry from the "murmuring pines and the hemlocks" of the virgin forest.

In the program of cooperating with farmers in demonstrating how their lands should be operated to conserve soil and moisture, and incidentally to reduce damage by floods, the Soil Conservation Service has a clause in the standard cooperative agreement providing: "The cooperator agrees to protect to the best of his ability from fire all wooded and other areas not used for farm crops." Approximately 4,500,000 acres, or half of the farm land under agreement for erosion control, is now so protected.

The second greatest enemy to the farm woods, and therefore to the influence on moisture conservation, is grazing stock. Farmers, in cooperation with the Service, lead the way in bringing about better wood conditions through the exclusion of stock on approximately 900,000 acres.

More than 200,000 acres on steep slopes, or land otherwise in a condition to add to the flood menace, have been planted with trees on these cooperating farms. Were all similar farm lands treated in like fashion, many more million acres of woods would be added to those already established and now dedicated to woodland growth and use. Desirable, however, as is the conversion of such erodible lands to woodland use, most immediate and far-reaching effects are to be obtained when the farmers put their 185,000,000 acres of woods permanently into the best condition to prevent run-off.

While some farmers recognize their responsibility in using a natural resource in a way to promote lasting human welfare in the United States, most individuals cannot afford to be guided wholly by altruistic motives. There must be economic returns to justify an adequate and permanent land use. Therefore, to show how this may be brought about by proper woods management, there have been established over 8,500 demonstration areas of approximately 5 acres each on the lands of cooperating farmers.

By following the principles demonstrated, the sustained woodland returns made possible will serve to induce the owner to keep such erodible lands in protective woodlands rather than to use them for crops which would not only bring about erosion and undue run-off, but would result in constantly decreasing land returns.

The farm woodlands are generously and widely distributed throughout the country, especially areas in the East. Their distribution and the character of land upon which they are found make them deserving of immediate attention in a flood-control program. At least 15 percent of the land in the eastern United States would be in the best possible shape to prevent floods if the farmers who own the land would rationalize their management of the woods so as to allow Nature to function as it does in the primeval forest or in any decently managed woods. The experience of the Service shows clearly that much more of the farm land should be restored to forest growth, as the logical and best land use, than anyone had previously dared to guess. Proper land use will probably raise the figure of 185,000,000 acres by perhaps as much as 50,000,000 acres. These are indeed important data in any plan of flood control.

VEGETATION CUTS COSTS

By Barrington King [1]

AN INCREASE in the use of vegetative protection for terrace outlet channels in projects and camps in the Southeast, accompanied by a decrease in the cost of this type of protection, sent costs down 57 percent from July to December 1936.

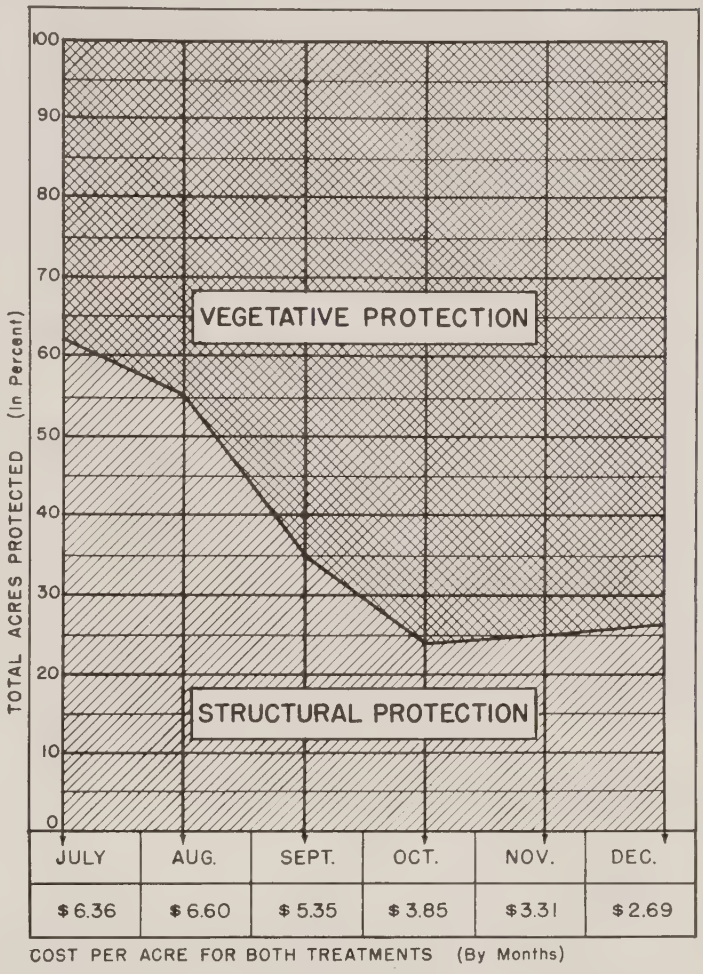
With the exception of a slight rise in the combined costs of vegetative and structural protection during the month of August, the costs were progressively lower each month during the last 6 months of 1936.

At the same time structural protection, which amounted to more than 60 percent of the total in July, dropped to less than 25 percent by November 1 and remained at approximately that proportion of the total throughout the remainder of the calendar year.

The farmer is in better position to contribute toward the cost of vegetation protection than toward the cost of structural protection, although this is not a factor in the reduced costs, since all contributions by the farmer are included in the total cost of treatment.

An indication of better cooperation, however, is seen in the fact that during the past 6 months the percentage contributed by the farmer toward the total cost of material increased from 6.1 to 7 percent, along with the general increase in the use of vegetative protection.

The accompanying graph shows the relative proportion of each type of protection and the cost per acre by months over the 6-months' period.



[1]Associate information specialist, Soil Conservation Service, Spartanburg, S. C.

ECOLOGICAL PRINCIPLES

(*Continued from p. 54*)

upon makeshift actions and temporary expedients. These broke down because the plants used were lacking in economic qualities, or the integrations and plans did not conform to normal plant successions.

There is definite need, as an aid to soil conservation, to develop crop and erosion-control plants of superior economic quality and to devise integration and vegetative cover management which will follow such patterns of plant succession as will give sustained yields at all times.

Such adjuncts as debris basins and check dams must play an important, but temporary, part in the erosion-control program. The heavy toll taken by erosion on lands under tilled crops must be overcome by farming systems that are in harmony with the normal climatic and vegetational processes. An approach to this is now being made in the form of strip cropping, but it is possible to go far beyond this in the direction of soil-building vegetational systems. An understanding of Nature's principles and methods has already been attained in fair measure with respect to climax vegetation, the processes of plant succession, and the use of plant indicators in determining what has happened and what can be made to happen.

ANNOUNCING FOR OCTOBER

Next month's leading feature will be an article by Dr. C. W. Thornthwaite, "The Hydrologic Cycle Reexamined."

ENGINEERING PHASE

T·B·Chambers[1]
on

The use of vegetation in mechanical erosion-control structures

EROSION control must follow nature's precepts. A protective covering of vegetation is the most effective measure against the impact of falling raindrops and the scouring action of running water, and, in addition, it assures the infiltration needed to reduce run-off. On cultivated slopes it is, however, impossible to reproduce a native cover, and the erosion specialist must resort to management of the cultivated cover to simulate, as nearly as possible, natural conditions. Even then, it often becomes necessary to employ supplementary or complementary mechanical measures.

The erosion control engineer is faced by many problems. In the forefront is the fact that adequate construction must be had within the limits allowed by land values and land-use adaptability. Conventional materials, such as concrete or masonry, are usually too expensive to be used for lining channels, paving spillways, or for many other purposes where their use would ordinarily be indicated in another type of program. While such materials can be economically used in a few places where special crops of high value are grown, or where run-off from large drainage areas is concentrated, their costs are often prohibitive on the vast areas devoted to conventional crops. For a cheap, effective construction material the engineer must turn to vegetation. But in using vegetation the problem of design becomes complicated because there is no background of experience to indicate values of strength or resistance to wear that such materials will afford when subjected to the forces of running water. Cut-and-try methods have been necessary in all cases where vegetation and other nonconventional materials of construction were used, which necessarily retarded the progress of the work. Field experiments are now being conducted which have partially developed safe values for design purposes. Where actual values are not known the only recourse is to play safe by using values somewhat below the indicated maximum, which results in more expensive structures. Future research and a critical analysis of field practices should develop factual data that will enable engineers to use definite values for different types of vegetation when used under varying conditions of soils, slopes, and climates.

In serving as a channel lining, vegetation is subjected to much greater destructive force than would be true on undisturbed slopes where normally run-off would flow in thin sheets at low velocities. Special care must be used in preparation of the seedbed. The soil should be well fertilized and it is usually necessary to provide a temporary protection until a dense sod is formed. The use of what might be called "heavy duty" vegetation in such treatment requires relatively high installation costs and careful maintenance throughout the life of the structure.

Protection of Channels

Under favorable conditions the use of vegetation as a lining material for terrace outlet channels is highly desirable. It will ordinarily be subjected to only short periods of flow occurring at infrequent and irregular intervals. These will usually promote rather than retard growth. Where slight damage occurs from an exceptionally high flow, there is generally ample time for healing by new growth before the next flow period.

Vegetated outlets are used for low-velocity channels in the eastern half of the United States from Florida to Wisconsin. Bermuda grass is the most effective in the South, while farther North ryegrass and the pasture mixtures are used. In locations where adaptable, Kentucky bluegrass has proved highly successful.

An example of the use of vegetation in channel lining is cited from the experience of field engineers in Texas. When the new demonstration projects were established there in 1935, vegetated outlet channels were designed for a velocity of 5½ feet per second. The prevailing topographic and slope conditions limited the drainage area to 30 to 50 acres. On larger watersheds, where the velocity when concentrated in one channel would exceed 5½ feet, it was planned to use concrete or masonry overfall dams to protect the channels. Subsequent field tests proved that channels lined with Bermuda grass were capable of sustaining a velocity of at least 8 feet per second for period up to 30 or 40 minutes. This permitted drainage of over 100 acres into a vegetated channel and permitted a reduction of 95 percent in the contemplated masonry structures. Much lower costs were entailed and, at the same time, better farming practices were maintained by utilizing the channel area for grazing and forage production.

(*Continued on p. 62*)

[1] Head, Engineering Section, Soil Conservation Service, Washington, D. C.

1. *Kudzu protecting a steep bank.*
2. *Vegetated meadow strip serving as outlet for terrace discharge.*
3. *Terrace outlet channel protected with vegetation. Mulch has been used on the bank slopes in connection with seeding.*
4. *Small wire dam protecting gully head while grass is being established.*
5. *Close growing filter strip of vegetation above diversion channel.*
6. *Oat strips over level terrace serve as filter for terrace channel and protect ridge against damage from overtopping.*
7. *Highway ditch and back slope protected by Bermuda grass.*

10700—37——2

Vegetation for Soil Conservation

(*Continued from p. 60*)

Outlets may consist of well-vegetated meadow strips prepared by seeding or sodding a natural drainage way. When feasible, this use is to be preferred to constructed channels, because the preparation of the natural drainage way is less expensive and it affords more income from the production of hay or pasturage.

A farmer in North Carolina objected to establishment of a lespedeza and grass meadow strip across one of his largest and best fields. His opinion was that too much land would be retired from cultivation. The next season he cut 7½ tons of hay from the strip and received a higher income per acre from it than from any other part of the farm. At the same time the strip afforded perfect protection as an outlet for the terrace system.

The flow line of gullies and natural channels may be successfully protected by dense, close-growing types of vegetation when the soil and slope are favorable and the velocities are not too great. This method is used most often where it is impractical to divert water away from the gully. Sometimes it is necessary to use low, temporary dams for immediate protection while vegetation is being established. By the time the dams are no longer effective the vegetation may ordinarily be relied upon for permanent protection. Under more favorable conditions native vegetation will often afford ample protection if the gullied area is protected from grazing and fire while a cover is being established.

Water should not be concentrated any more than necessary. Locations will often be found where individual terraces or other water-carrying structures can be emptied on to pasture or woods, obviating the necessity of a prepared channel. Here vegetation is not used as a material of construction, although it does serve in conducting concentrated water to a lower elevation.

Spillways

Dams for soil- and moisture-conservation purposes are often located on small watersheds, or in other places where flow is infrequent, and masonry spillways cannot be afforded. The erosion engineer meets this situation by placing dams in locations where a wide natural surface can be used for discharging the overflow at low velocities. Low velocity and infrequent flooding permit native vegetation to withstand successfully the cutting force of the water, even in the more arid sections of the country where a sparse growth is common. By flooding wide areas, more vegetation and a healthier growth are produced from the increased moisture, affording better range or pasture and additional protection to the dam. In such situations the judgment of technicians must be relied upon for safe design, since no definite values can be assigned to vegetation under the wide variety of conditions encountered.

Terraces

Vegetation is sometimes used in connection with terraces to protect the ridge against scouring and cutting because of overtopping. Drainage-type terraces are designed with a grade that will not produce erosive velocities and consequently protection is not needed in the channel although it is desirable immediately above. Many farmers and technicians object to the use of close-growing vegetation on newly constructed terrace ridges since it prohibits the proper seasonal maintenance of the terrace, and its protective value is doubtful on graded terraces.

On the level, absorptive-type terrace close-growing vegetation offers very definite protection from blowing and from water damage when overtopped and should be maintained continually on the ridge. The level terrace is designed to impound all run-off from normal rains, but the ends are left partly open as a safeguard to discharge run-off from exceptionally high rainfall. Even with this protection, overtopping occurs occasionally and, unless protected with a dense vegetation, the ridge may be severely cut and the slopes eroded. Vegetation should also be used at the terrace ends where flow may reach erosive velocities.

Protecting Banks

Almost any bare, unprotected bank may be stabilized with vegetation if the concentration of water flowing over it is not too great. Gully banks, stream banks, and the slopes of highway cuts and fills may be amply protected under most conditions. Shrubs, vines, or trees may be used in addition to the heavy, tufted grasses, depending on the nature of the job to be done and the time limits. On places where heavy concentrations occur, it may be necessary to aid growth by fertilizing, soil conditioning, or structural protection, to establish a "heavy duty" vegetal cover. Individual terrace outlets over banks of 45° slopes have been successfully protected with Bermuda grass established on a well-fertilized layer of topsoil.

Vines having the power to take root from stolons are particularly valuable for protecting steep banks.

It is not necessary to attempt planting on the steep surfaces, inasmuch as the vines can be planted above or below and will spread from there. Vertical gully banks 30 feet high have been successfully stabilized with kudzu vines. Dense-rooted shrubs are valuable, as well as trees, and are used where they do not interfere with other uses of the area.

Protection of Diversion Channels

While vegetation is seldom used on diversion channels it is best to have the protection of close-growing vegetation immediately above it if the effectiveness of the channel is not to be impaired by excessive silting. Soil material moved by erosion on cultivated or unprotected areas above a drainage channel will be deposited on entering the channel. A close-growing, permanent strip of vegetation 2 or 3 rods in width immediately above the channel is usually sufficient. When located immediately below a pasture or wooded area additional protective strips are seldom necessary.

Strip Cropping

The action of strips of vegetation in removing soil material from running water is entirely mechanical. Strips of relatively narrow width, if the vegetation is of sufficient density to spread the water and check its velocity, have proved highly effective as desilters, and are valuable in holding eroded soil material on the slope. When used in connection with diversion channels or terraces the erosion hazard is further reduced. When strips are used independent of mechanical measures the water—except for the relatively small amount retained by increased absorption within the stripped area—will continue down the slope in increasing amounts to erode unprotected areas. As in the use of vegetation in structures, additional experimental data is needed before the soil conservationist can attribute definite values to strip cropping as an erosion-preventive measure.

Methods of Establishing Vegetation

In using vegetation as a structural material where a definite value must be placed on its ability to withstand external forces, it is necessary that its density, vigor, and root growth conform to a standard. Haphazard methods of seeding, sodding, or planting are not usually satisfactory and improved methods have been developed by engineers working in cooperation with other specialists. When solid sodding is used the strips must be cut to uniform thickness and width so that when placed in the new location the pieces will fit closely and accurately, and form a smooth, uniform surface. To insure immediate and vigorous growth a bed of topsoil and fertilizer is generally necessary. Methods of strip sodding have been greatly improved by field engineers in the last few years. The strips are countersunk in close-fitting trenches placed at right angles to the direction of flow and are tamped in place. The strip, while serving as a base from which a grass may spread over the entire area, also acts as a barrier to scouring and channeling. Fertilization is very necessary with strip sodding in order that the intervening areas may be covered as quickly as possible.

A mechanical method of sprig sodding has been developed by engineers for use in sodding pastures or banks with Bermuda. Pulverized turf is scattered with a manure spreader and then disked. The method has proved adaptable where considerable time is allowable and has reduced the cost of sodding highway banks from 8 cents to 2 cents per square yard.

In establishing a channel lining by seeding, it has been found necessary in most cases to use one to two inches of mulch, securely held in place, to prevent seed being washed away, and to give increased moisture and protection to the young plants. Mulching is also used when seeding on banks and severely eroded areas of steep slopes. Straw or other vegetal litter and brush have been successfully used as a mulch.

Machines to facilitate handling of vegetal materials have been developed, including numerous types of sod-cutters and loaders, contour furrowing machines, and seed harvesters for gathering seeds of wind grasses and other unusual plants that offer promise as soil binders.

In using vegetation the engineer must be sure that protection will be afforded when needed. Seasonal and climatic conditions present many hazards. Frequently overgrazing, burning, or disease so damage vegetation as to make it useless for erosion-control purposes. It is important that the plants used are adaptable to the location, that the soil has ability to produce, and that the growth characteristics of the plant are fully known. In some areas the highest rate of run-off occurs immediately after the snow melts and before any growth begins. Under these conditions a type of vegetation such as perennial grasses that form a heavy protecting turf would be necessary. In

(*Continued on p. 70*)

SLOPE USAGE

S·B·Detwiler[1] reviews some of the opportunities for improved hillculture farming

SAFE and profitable use of sloping agricultural lands constitutes an important soil-conservation problem. Cultivation of slopes is responsible for severe losses of soil and water; yet the financial needs of the farmer are often such that he cannot afford to retire these lands from tillage and devote them to less remunerative forest or grass crops. Hill-culture research aims to find sound erosion-control practices that will provide the farm owner with the requisite supplemental income from safe use of steep, erodible lands.

Hill culture is founded to a considerable extent upon the principles evolved in Bergcultuur in the Dutch East Indies, and on the plan for "mountain agriculture" long advocated by Dr. J. Russell Smith of Columbia University. As applied to the United States, hill-culture research aims to perfect an ecologically correct and economically practicable system of managing erosion-resisting vegetation consisting of superior selections of trees, shrubs, and perennial herbaceous plants. In addition to fully conserving the soil and water on sloping farm lands, the purpose is to produce early economic returns from plant products having high potential commercial values such as tannins, oils, waxes, plastics, food, forage, and specialty products which will not compete injuriously with established domestic crop production and marketing.

Agriculture and horticulture apply scientific principles of economic plant improvement but have limited regard for ecological principles in managing vegetative cover. Silviculture is founded on sound ecological management but is limited in the application of plant improvement principles, since forest crops are not primarily adapted to production of fruits, foods, and forage products which thus far have been the main consideration in plant improvement research. Hence, hill-culture research occupies a distinct field of its own, and offers opportunity for real service in the advancement of erosion-control practices founded upon scientific management and use of superior perennial vegetation yielding early and valuable crops on sloping farm lands.

Ecological methods of managing agricultural crops have made the greatest advance in the Dutch East Indies and Malay States under the incentive of specialty crops from trees and shrubs such as coffee, tea, spices, cacao, cinchona, and rubber for export trade. There, clean culture under high rainfall conditions rapidly depleted soil fertility, and scientific erosion-control farming was evolved through necessity. The original meaning of Bergcultuur was the cultivation of mountain and hill lands, as opposed to farming on level lands. About 40 years ago some of the large plantation estates began work to improve quality and quantity of yield through plant selection and breeding, and to experiment with methods of maintaining soil stability and fertility through management of perennial ground covers.

During the past 25 years, rapid progress has been made due to the establishment of hill-culture experiment stations and publication of "De Bergcultures", a weekly journal sponsored by the General Agricultural Syndicate and the experiment stations of Netherlands–India. The chief methods employed are maintenance of shrubby ground covers, especially leguminous shrubs; protective "shade" trees of leguminous

(Continued on p. 66)

[1] Head, Section of Hill Culture Research, Division of Research, Soil Conservation Service, Washington, D. C.

THE PICTURES

(Courtesy Bureau of Plant Industry)

1. *Fruiting branch of pawpaw.*
2. *Pawpaw tree of unusual size.*
3. *Japanese quince (left) and pawpaw (right).*
4. *A million Japanese persimmon fruits on storage grounds, Fo Tzu Chuang, Japan.*
5. *Shipmast locust posts (left), good as new after 60 years' service. Those on right still useful after 110 years in ground.*
6. *Wild hazelnuts (left) and an improved strain (right).*
7. *Ginkgo trees on the Mall in Washington, D. C.*
8. *Fruiting branch of the Ginkgo. A native of China, widely planted here for ornament. The nut has a sweet, edible kernel.*
9. *Branch of Russian olive laden with fruit useful for jelly and bird food.*

10 and 11. *A new hybrid of the Chinese hairy chestnut and the Chinquapin; blight resistant, prolific and hardy from Maryland south.*

12. *A superior Japanese persimmon.*
13. *Chinese holly. Crimson berries and glossy leaves, superior for Christmas greens. Thrives in hot, dry climates.*
14. *Native sumac. A valuable erosion-control plant yielding a high grade of commercial tannin.*
15. *Luscious fruits of jujube.*
16. *Ordinary, crooked black locust (left) and the superior shipmast locust (right).*

1
2
3
4
5
6
7
8
10
11
12

(Continued from p. 64)

species; intensive selection, breeding, and testing of crop trees and shrubs; economical methods of vegetatively propagating the selected strains of crop plants; green manure pits, silt pits, simple terraces, and other erosion structures if required; and effective organization, upkeep, and protection of the plantations. The system is especially dependent upon managed shade and ground cover vegetation and improvement of crop plants through systematic and intensive selection.

Many excellent perennial plants are now grown as farm crops, but as yet no one has attempted to develop for the United States a complete and scientific soil-saving farming system based on effective integration of such plants. Our factory-like methods of farming are destroying our source of life—the soil itself. Chemistry can aid in making hill culture profitable through devising ways to use our uncultivated plants, species of the fields, woods and thickets. Plant breeding can do even more than chemistry, because so few of our native plants have been worked with seriously for improvement of their fruit, yield and erosion-control qualities.

Superior varieties of nuts are so well recognized as a crop for erosible lands that the Tennessee Valley Authority has employed a nut-culture specialist. There are a dozen or more recognized varieties of black walnut yielding nuts of high cracking quality, and several good butternut varieties. The Japanese heart-nut is considered by many to be the best of all nuts. Hardy varieties of English walnut grow as far north as Ontario, as do also hard-shell almonds. There are many superior varieties of shagbark hickory, and also a cross between this species and the bitternut which has the rapid growth so often found in hybrids, bears early and yields well of fine-flavored, thin-shelled nuts. Many superior forms of pecan selections have hill-culture value and several pecan-bitternut hybrids appear promising.

Dr. Kent Beattie, of the Bureau of Plant Industry spent 3 years in the Orient making intensive selection of the best forms of Chinese and Japanese chestnuts and his work will be of especial importance in hill-culture development. A hybrid chinquapin is available, as are also selections of the American hazelnut. Nut culturists predict that continued selection of the American hazel will develop nuts superior to the European filbert, without the damage from blight which often makes filberts hard to grow here. The Chinese tree-hazel and large-fruited forms of beech offer additional opportunities. In warmer regions, pistachio nuts, selected strains of California hybrid walnut, soft-shelled almond, and Jojoba nut have possibilities. The latter grows wild in arid sections and the nut meat contains 50 percent oil similar to sperm oil.

Various pine nuts can be developed for greater commercial use through selection methods. Large quantities of unselected pinon nuts are marketed each year, beside furnishing an important part of the diet of many Indians.

The wild apricot of Turkestan grows in a cold, arid region and yields fruit of surpassing flavor. The pits as well as the flesh are a staple food of the natives, having a well-flavored and nourishing meat. Selections have been made by the Bureau of Plant Industry for fruit having quality, size, and richness of flavor.

Other edible fruits for hill-culture development are numerous. Here special opportunity exists for choosing hardy native trees and shrubs of high erosion-control value and pcssessing superior fruit for use in jellies, fruit juices, dried fruits and preserves as well as for forage, waxes, oils, and other commercial products. The Hansen bush-cherry has been developed through selections covering 40 generations and has hillculture value, as do also the selected strains of the very hardy Chinese bush-cherry. The native blueberries, high-bush cranberry, and other viburnums, service berry, various wild plums and wild grapes, and papaw, have been selected for superior fruiting qualities. Selections are available of native persimmon for seedless fruit, large fruit, early and late ripening, and high yield; and hardy varieties of Japanese persimmon grow as far north as Tennessee.

The jujube in the Southwest offers possibilities for development without cultivation. Next to dates, the native persimmon and the jujube have the highest food value of any of our fruits because of their exceptionally high sugar content. Japanese quince grows well without cultivation, is free from the most serious troubles of the European quince, and furnishes industrial products. A native elderberry has been developed that produces heavily. Many superior heavy-bearing mulberries are available, and, like the persimmon, the luscious fruit has possibilities as feed for domestic animals.

All of the Elaeagnus species are good erosion-control plants and several of these bear large, well-flavored fruits, fine for jelly. European dogwood produces fruits as large as pie cherries which are so relished by children and birds that it is difficult to collect seed. Himalayan blackberry and the Oriental trailing raspberry are now in use for erosion-control planting; both

are resistant to the troubles of cultivated Rubus and yield marketable fruit in abundance.

The commercial fruits adapted to hill-culture production are barely touched upon in the preceding list. Legumes for forage, waxes, insecticides, resins, oils, and tannins are equally extensive. Several of the new shrubby lespedezas have done well in erosion-control plantings, and offer possibilities as ground-cover plants, as does crown vetch. With valuable new plants of this sort, there are also opportunities to produce seed commercially. The American Genetics Association held a contest several years ago to locate honey locust trees producing thick, sweet pods suitable for a rich food for cattle as well as offering commercial possibilities for resins, wax, and sugar or syrup. Mesquite and carob produce heavy crops of beans in the Southwest that are highly valuable for forage and industrial uses, and can be improved by selection.

Shipmast locust is a variety of black locust which has a tall, clean, very straight trunk suitable for piling, posts, sills, ties, etc. Its ordinary life as a fence post is from 50 to 125 years. It is equal in growth rate to common locust and not subject to as serious borer damage as is the latter. Work done in the Bureau of Entomology and elsewhere indicates possibilities for developing a black locust even superior, for erosion-control purposes, to the Shipmast variety. It is possible to develop a thornless black locust through selection. Special values of locust and other leguminous trees are their protective and fertilizing properties when properly integrated with other trees and shrubs grown for their commercial products.

Tannin-producing crops offer favorable opportunity for the new type of farming. Sicilian sumac is imported by the tanners in considerable quantities and our native sumacs are also used. R. W. Frey, of the Bureau of Chemistry and Soils, believes selections of native sumac can be made to equal the selected Sicilian forms for superior tannin. The Sicilian sumac industry is highly developed and exportation of plants or seed is prohibited.

The entire world uses about 940,000 tons of 25-percent tannin extract annually, of which about one-half is used in the United States. Chemical substitutes for tannin were developed about 1880 and have been in commercial use for the past 35 years; synthetic tannins are used to improve color and accelerate tanning. Mr. Frey does not expect chemicals to supplant the vegetable tannins for heavy leather of which it is estimated that some 350,000,000 pounds per year are made in this country.

At present the United States imports about 50 percent of the tannin materials it uses, and over 60 percent of the domestic material is derived from chestnut wood. Chestnut is now being steadily destroyed by chestnut blight, and in a relatively few years compared with the time required for trees to grow the tannic acid extract business based on native chestnut wood must cease for lack of wood. The United States appears to be increasingly dependent in the future on imported vegetable tannin materials; hence this country might find itself in difficult circumstances in case of war.

The development of a new domestic tannin crop is of great interest to the erosion-control program, since it offers a chance to utilize large areas of erosive soils in growing perennial plants high in tannin value. Mr. Frey and other tannin experts consider canaigre, a sour-dock plant native to the Southwest, a worthy possibility. Mexicans and Indians have long used the heavy root of this plant for tannin purposes. The supply of native plants was nearly exhausted by collection and shipment to England and Germany about 50 years ago. Canaigre is recognized abroad as furnishing a first-class tannin. The plant can be grown with or without cultivation over one-fourth to one-third the area of the United States. A program of research on the possibilities of canaigre is now under way in the Department.

The production of holly and other similar plants for Christmas greens is another potential industry for hill culture. Many farmers now secure income from holly greens—estimated at $150,000 per year in southern Maryland. For Christmas holly, the Chinese holly, *Ilex cornuta*, is especially desirable because of its relatively fast growth and handsome berry production, but this species seems best adapted to the drier and warmer regions. Carefully selected native holly trees need to be worked with in the East.

Maple sugar orchards furnish a common example of applied hill culture; maple sirup and sugar now provide regular and important cash returns to many farmers. Underplanting maple orchards with economic shrubs, such as the improved hazel nut, high-bush cranberry, and blueberry, would tend to improve conditions for growth and yield of the maple trees and furnish an additional source of income. A recent study has shown that maple orchards having a shrubby ground cover have better conditions for their growth.

Hill-culture plantings, after the annual crop values of the plants are no longer profitable, may furnish a final

(*Continued on p. 83*)

PROPAGATION

An article by F·J·Crider[1]

Little known plants find their place in the sun

TO CARRY forward effectively the vegetative soil-and moisture-conservation program of the Soil Conservation Service, plants are needed—an inconceivable number of plants—for gully slope stabilization, to prevent sand blowing and to reclaim bared lands, to control the insidious land destruction caused by sheet erosion, for protection of terrace outlets and for many other purposes connected with the conservation of soil and water. The nurseries of the Service serve as the ready source of supply through which all propagation materials used in erosion control are made available to the using agents—agronomists, foresters, and biologists. Virtually every member of the field force—be he botanist or waterboy—is a plant hunter. The possibility of discovering a hitherto unused species or variation possessing valuable characteristics useful in erosion control colors the daily routine of the worker. The quest for plants with existent, outstanding erosion-resistant qualities goes on continuously. Thus, by adding to those already recognized as useful, the nurseries bring together large collections of both native and introduced plants for observation and eventual quantity production and utilization.

During the nursery observational period all possible data are obtained having to do with the characteristics and methods of handling the plant and its adaptability to particular environments and uses, looking toward its ultimate establishment in the field or under natural range or forest conditions, as the case may be. This serves not only as a further indication of its practical values but provides essential information for subsequent use by both the nurserymen and those more directly responsible for planting out the material on demonstration project and C. C. C. camp areas.

For those plants agreed upon as possessing the desired characteristics for general field utilization, effort must be made to determine successful methods of propagation, the practices finally adopted to be simple, easily applied, and adaptable to quantity multiplication. Also, there must be found out, particularly in the case of plants such as grasses and legumes, all the facts possible regarding the common though highly important farm practices, such as proper rate and depth of seeding and time and method of planting, as well as any other information essential to successful establishment under conditions where the plants can be most effectively used in the soil- and moisture-conservation program.

As to what constitutes erosion-resisting characteristics in a plant, this depends in large measure upon how the plant is to be used and the location to which it is to be adapted in the revegetation program. This can perhaps best be illustrated by typical examples. It being known that a rapid growing, stoloniferous grass was badly needed for quick cover on the heavy soils throughout the Central and Northern Great Plains, attention was directed to western wheatgrass, *Agropyron smithii*. Adapted to such soils and having excellent soil-binding properties, some of the better types or variations were sought out and assembled in the nurseries for observation and quantity increase. At the same time, large quantities of seed were harvested from native meadows. The fact that this grass produces excellent yields of seed which is easily harvested and that the establishment of young seedlings is fairly simple, adds to its value in general erosion-control operations. Favorable reports resulting from its rather wide use in reseeding and soil-protection operations in certain sections seem to justify the intensive observational studies in the nurseries.

Buffalo grass, *Buchloe dactyloides*, is another example of a stoloniferous plant which, by reason of the assemblage of desirable variations in the nurseries and the development of special methods of harvesting the seed under natural conditions, fits ideally into the observational phase of the nursery program. This native species is dominant in the short-grass areas of the Great Plains, forming a dense sod where protected from over-grazing. The species is dioecious, the male and female plants usually being found in colonies, but more or less intermingled. The seed is produced in a short-stalked bur that makes harvesting by mechanical means extremely difficult. The seed is also subject to a fungus disease which materially lowers its viability during certain years. The grass can be satisfactorily propagated, however, by means of vegetative cuttings, and extensive use of this method is now being made in the sodding of terrace outlet ditches and gully structures. Buffalo grass is very nutritious and is utilized widely as a forage plant throughout the range of its adaptation.

Always on the lookout for erosion-resisting plants adapted to a wide range of soil and climatic conditions,

[1] Head, Section of Conservation Nurseries, Soil Conservation Service, Washington, D. C.

field workers early recognized that Canada wild rye, *Elymus canadensis*, possessed these general characteristics, and this grass is now being propagated for seed increase in the nurseries of the Northwest, with special selections under observation for specific uses on demonstration projects. It forms an abundance of vegetative growth and is easily established from seed. The species is not very palatable, a quality which of itself may be considered an asset where there is a tendency toward too heavy grazing. Many of the more palatable native grasses have practically disappeared from our ranges due to overgrazing. Given a chance under proper climatic conditions, Canada wild rye should aid materially in the reclamation of soils that have been overcultivated and overgrazed.

It is considered particularly fortunate when a plant shows throughout the observational period several distinct characteristics required for the erosion-control program. Such a plant is sheepbush, *Pentzia incana*,[2] the shrubby perennial from South Africa. The program requires plants resistant to drought, with procumbent growth habit for prevention of sand blowing as well as sheet erosion. Sheepbush, which becomes dormant during the dry season and is immediately rejuvenated with the first rains, is extremely drought-resistant and is a distinctly layering shrub. In times of severe drought when other vegetation fails this plant can be depended upon for forage for sheep. In addition it has the distinct advantage of reseeding under natural range conditions. Originally it was thought that this shrub was adaptable only to the extreme Southwest, but recently it was found to withstand a temperature of 17° (Fahrenheit) below zero, thus making it of value for wide adaptation in regions throughout much of the country where prolonged droughts occur and where wind erosion is severe.

Being constantly on the alert for plants possessing high erosion-resisting values combined with high soil-building properties, the nurseries in the Southeast are just now starting to increase in quantity a bushy variation of lespedeza which gives unusual promise for these particular purposes. Both the agronomists and the wildlife people are interested in this legume as it is known that the plant can be used successfully in the Southeast for strip cropping and that its seed is relished by birds. The quantity production of this highly desirable accession will go forward during the next year at the Clanton, Ala., nursery where land has recently been purchased for a large combination observational and quantity production nursery unit.

[2] This foreign species was described in vol. 2, no. 7, Soil Conservation: Observational Plantings in the Nurseries.

In the Northeast, centered at the observational nursery near Ithaca, N. Y., notable results are being obtained in the assembly of species and strains of grasses and legumes possessing both soil-building and soil-binding characteristics. Wild white clover, an introduced species from England, is worthy of special note. This plant is compatible with grasses and other clovers, and like other legumes enriches the soil with an accumulation of nitrogen and organic matter. Pasture-type timothy and orchard grass as well as improved strains of rye grass are now being grown here prior to their production in quantity for use on demonstration projects.

It is a significant fact that these and many others of the selections showing most promise for use in the erosion-control program of the Northeast represent the product of European plant breeding stations. This greatly simplifies the work of our Service which now merely consists of the assembling, observational testing, and increase of strains that were developed previously through years of painstaking research.

Plants which maintain hardiness under the most arid of conditions are necessary in order to lick the severe erosion problems of the Southwest. Two grasses showing great promise in this section are the lovegrasses, *Eragrostis curvula*, and *E. lehmanniana*, which came to us from South Africa. In the nurseries of the Southwest they have passed the initial testing stage and, showing pronounced erosion-resistant characteristics, are being increased in quantity for the first time for practical utilization. They produce an abundance of vegetative growth and heavy crops of seed, with the further desirable quality of propagating both by seed and vegetatively. Although appearing not to be winter hardy in the north, preliminary trials indicate they may have a place in the agriculture of our more northern regions as annuals due to their ease of seeding and rapidity of establishment.

Although slower in immediate results than the grasses and other forage crops, observational plantings of the tree and shrub types include species which have already shown sufficient evidence of superior merit to warrant their quantity increase. Into this category come the Ozark white cedar, *Juniperus ashei*,[3] and the Japanese trailing raspberry, *Rubus parvifolius*, both of which possess the characteristic of being highly resistant to plant diseases, as well as supplying abundant food for birds. The raspberry, in particular, on account of its rapid growth and stoloniferous, mat-forming habit, has high soil-binding, erosion-resistant properties. This lucky find was brought into the United States by the famous plant explorer, P. H. Dorsett, of the Division of Plant Exploration and Introduction, Bureau of Plant Industry, in 1929. Since that time the plant has been under investigation by Dr. G. M. Darrow of this Bureau, from whom propagation stock was obtained for distribution and trial in our observational nurseries.

Heavy litter-producing capacity, ability to withstand competition with less valuable plants, tolerance of unfavorable soils, desirable fruiting habits—all these and many other qualities are sought in order that trees and shrubs for windbreaks, woodlots, buffer strips, game food and cover, and general soil stabilization may contribute in fullest measure, along with grasses and other forage crops, toward rounding out the vegetative soil- and moisture-conservation program of the Service.

[3] Described in this issue, by Charles F. Swingle: A Promising New Cedar for Erosion Control.

ENGINEERING PHASE

(*Continued from p. 63*)

warmer climates a stoloniferous grass, overseeded with rye or other winter grasses when the occasion demanded, would offer complete protection to channels the year round.

The soil-erosion engineer has made marked progress in the development and use of vegetation in conjunction with mechanical erosion-control measures. Very little was known prior to 1933 about the possibilities of these measures. The erosion engineer desires to continue their improvement, together with a more complete usage of vegetation as a construction material. The development and enlargement of his activities in this direction will depend upon obtaining facts on which he can rely. He hesitates to stake his professional reputation on the use of materials about which he knows next to nothing, and which are susceptible to so many hazards. It has been said by a man high in the engineering profession: "A true engineer is as much born as a poet or any other artist, but he is cradled on palpable material and nursed on facts, not metaphysical ideas."

SUBSCRIPTIONS ACCEPTED

Soil Conservation has a very limited free distribution. Private individuals and others who may wish to obtain the magazine regularly are advised to send their subscriptions to the Superintendent of Documents, Washington, D. C. Terms are $1 per year, domestic; $1.40 per year, foreign.

OCTOBER FEATURE

"The Bermuda Grass King" is the title of an article by Angus McDonald, which will appear next month.

Purple-headed wild rye
(Elymus glaucus var. jepsoni)
Sheep fescue
(Festuca ovina)
Orchard grass
(Dactylis glomerata)
Big bluegrass
(Poa ampla)
Siberian wild rye grass
(Elymus sibiricus)
Meadow barley
(Hordeum nodosum)
Idaho fescue
(Festuca idahoensis)
A. wheat grass
(Agropyron pungens)

GRASS SEED

Quantity production in nurseries is explained

by M·M·Hoover[1]

Power seed stripper developed by Tucson nursery. Collecting blue grama seed.

THE production of grass and other forage crop seed in quantity by the Section of Conservation Nurseries follows as a normal sequence in the development of the plant observational program of the Service.

When a particular accession, whether native or exotic, has successfully passed the initial observational tests and demonstrated its value in soil and moisture conservation, it is then ready to be grown in plats of sufficient size to produce seed in quantity for use on demonstration project areas. The observational tests supply fundamental information regarding the soil and climatic range of a given accession as well as growth characteristics and cultural practices necessary for successful establishment; but the production of seed in quantity is a specialized nursery activity contributing to the quantity utilization of the plant in various erosion-control practices.

The production of grass seed in quantity involves a change in cultural practices from those found most feasible on the nursery proper for handling the various accessions during the period of their initial observation. Although the primary purpose of the increase plantings is the production of seed in quantity, nevertheless the ease of propagation by practical methods and equipment in common use by farmers and seed growers are very important factors in determining the general usefulness of any of the new accessions in the vegetative program of the Service.

Methods of planting, harvesting, and threshing the various grasses have been developed at nursery centers where facilities were available for conducting this work. Equipment in general use has been adequate for most cultural operations; however, many of the new and better grasses require special adjustments to facilitate their most satisfactory handling—as regards both planting and harvesting operations. It is the general practice to employ, as nearly as possible, the same planting, cultivation, harvesting, and threshing methods used for increase seedings by private seed growers operating in the community.

Particular attention and care are given to such matters as rate, method, and date of seeding, as well as to all subsequent cultural practices, in order that this information may be made available to the private seed grower if and when the demand for seed of a given accession seems to warrant such general production.

Although most of the accessions now being increased in the nurseries have been the result of satisfactory performance in preliminary observational plantings, several are native species already known to have high erosion-resisting values and are being used extensively by our Service. A number of these, normally collected from natural stands, have been found to produce an unusually good seed crop when grown under cultivation. Special attention is being given to species difficult and expensive to collect.

Further careful study of comparative costs of obtaining seed of important native species from natural stands as compared with their seed production under cultivation may prove to be important factors in shaping future policy.

The advantages of growing seed of native grasses under cultivation depend primarily on the following: Certainty of a seed crop; higher yield per unit area; freedom from mixture; improved quality of seed; decreased unit cost of seed; and stimulation of seed production as a new farm enterprise.

The uncertainty of a satisfactory seed crop from natural stands, as well as the scattered distribution of

(Continued on p. 84)

Threshing Eragrostis curvula, *Tucson nursery. Yield of 300 pounds cleaned seed per acre. Two crops of seed were obtained this summer. One of the important introduced grasses which have passed through observational stage and are now in quantity production for project use.*

[1] Head, Grass Unit, Section of Conservation Nurseries, Soil Conservation Service, Washington, D. C.

WILDLIFE MANAGEMENT

William R. Van Dersal[1]
Writes about

Soil-saving plants that provide feed and cover for birds and mammals

THE soil conservation program at the outset included the development of the wildlife resource, wherever possible turning erosion-control operations to the advantage of wild mammals and birds.

Pioneering Plants

On demonstration projects and camp areas the use of pioneering vegetation in critically eroded or eroding areas had as a secondary result the production of adequate food and cover for wildlife. Fortunately, those plants that have demonstrated their ability to lead the way in the colonization and reclamation of eroded land are often among the best species for wildlife. They may be expected, because of their ability to initiate secondary plant successions, to thrive on the poorest sites and with their protecting cover to prevent soil washing. At the same time, if proper selection of plants has been made, they will offer the maximum of food and cover for wildlife at critical seasons of the year.

No experiment station nor plant testing station is needed to discover these pioneer species. They can be found in any gully or on any eroded land, appearing naturally, as the long process of reclothing the land is undertaken by Nature herself. The whole country, in fact, may be considered a testing ground wherein species of plants have for thousands of years succeeded or failed. The operation of natural environmental factors has effectually prevented all species except those best adapted to grow on barren sites from appearing as pioneers. Observation in the field can now show us the successful species and from these we may select those of particular value in encouraging wildlife. Mention of only a few outstanding types among the hundreds of pioneer species available for erosion control and wildlife plantings can be made.

Legumes and Grasses

Legumes rank among the best of pioneers. It is known, for instance, that the percentage of wild legumes in the native vegetation of impoverished soils is comparatively high, and that in natural revegetation, the percentage of legumes decreases with the increase of total nitrogen in the soil.[2] Their invaluable aid in improving soils is of the first importance to agriculture, not only in the usual crop rotation and green manure production, but in eroded soil reclamation as well. A fact not generally recognized is that from East to West legumes are of great importance to quail. The California quail gets more than 32 percent of its total food supply from legumes;[3] nearly 39 percent of the food supply of the southwestern Gambel quail consists of legumes;[4] and over 20 percent of the average monthly diet of the eastern bobwhite is composed of legumes.[5] It is obvious, therefore, that wherever it is practicable to use legumes in a properly planned erosion-control program, quail at least will be well supplied with food.

Grasses of many kinds, more notably those producing a lush growth, are much used by ground-nesting birds. Where proper selection of pioneer forms is made, establishment of thick grass cover on eroded areas can assist materially, often better than other kinds of vegetation, in conserving soil. Mixtures of grasses and legumes have proved of particular worth in erosion control and wildlife conservation in the Southeast.[6] The leaves of both grasses and legumes, as well as the seeds, are freely consumed by birds and mammals.

Woody Plants

Among woody plants certain genera appear of outstanding value. All species of *Symphoricarpos* (snowberry, coralberry) are pioneers, and 33 species of birds are known to eat the fruit. Coralberry (*S. orbiculatus*) has been used with considerable success for living check dams. The genus *Rhus* (sumacs) contains 20 species, most of which are pioneers. Nearly 100 species of birds and many mammals feed on sumac berries. The species of blackberries of great importance as pioneers on barren or eroded land are eaten by 146 kinds of birds as well as over 25 kinds of mammals. Sassafras, smilax, and vitis (grapes), in addition to furnishing pioneer species, have berries eaten by 18, 43, and 87 species of birds, respectively.

(Continued on p. 75)

[1] Biologist, Section of Wildlife Management, Soil Conservation Service, Washington, D. C.

[2] Campbell, E., 1927. Wild Legumes and Soil Fertility. Ecology, 8:480–483.

[3] Sumner, E. L., 1936. A Life History Study of the California Quail, with Recommendations for Conservation and Management. Calif. Fish and Game 21:177.

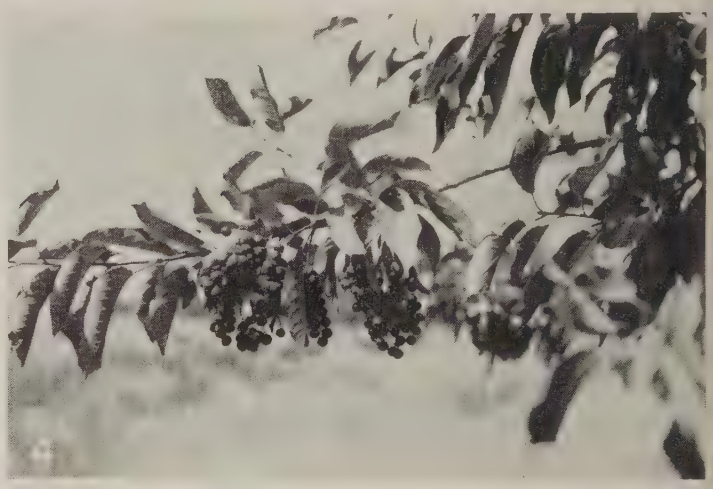
[4] Gorsuch, D. M., 1934. Life History of the Gambel Quail in Arizona. Univ. Ariz. Biol. Sci. Bull. 2:30.

[5] Stoddard, H. L., 1932. The Bobwhite Quail, Its Habits, Preservation, and Increase. 559 pp., illus. New York, p. 135.

[6] Stevens, R. O., 1937. Handbook of Wildlife Management. Region 2. 31 pp. mimeo.), illus., Spartanburg, S. C., March. p. 19.

2

3


4

5

6

7

8

The grapes, particularly, are utilized by a great many species of mammals.

The junipers are of outstanding value for wildlife not only as food but because they provide evergreen cover. The berries of the 16 native species are eaten by 50 kinds of birds and most noncarnivorous mammals. Unfortunately, the fact that the species grow very slowly, makes their use in an erosion-control program of less value than if they were rapid-growing. In conjunction with low-growing cover crops, however, and because of their ability to succeed on extremely severe sites, they have a very definite place in any program of wildlife management that also conserves soil.

The genus *Prunus*, containing some 44 wild species of plums and cherries, is superlatively attractive to numerous birds and mammals. One or another of the species pioneers in nearly every part of the country. They are being widely used, precaution being taken wherever necessary to prevent stock-poisoning by certain cherries. Wild plum (*P. americana*, *P. angustifolia*) seems to be of noteworthy value.

Ceanothus (Jersey tea, buckbrush) and *Arctostaphylos* (bearberry, manzanita) provide many pioneer and wildlife-encouraging forms. Species of the first genus possess nitrogen-fixing nodules and hence, like the legumes, assist in soil improvement. Others that find a use on various eroded sites being planted for wildlife could be mentioned, such as certain oaks, persimmon, buffaloberry, shrubby dogwoods, huckleberries, hawthorns, crabapples, chokeberries, and the introduced Russian olive.

Within a broad program of soil conservation the establishment on severely eroded sites of vegetation that is useful in the production of a wildlife crop is practicable and easy of accomplishment if intelligent selection of species and planning precedes operation.

THE PICTURES

Sumacs of west (1) and east (7) bear fruit attractive to wildlife and produce good cover on eroded lands. They are of great value to the cottontail rabbit.

The native **Lespedeza procumbens** *(2), occurring naturally on eroded soil, is a legume valuable to the bobwhite for seeds and greens. Note the accumulated litter below the early spring growth.*

Persimmons (3) are useful for erosion control and wildlife; the fruit is eaten by many birds and mammals.

Wild cherry (4), good for soil and wildlife conservation in ungrazed areas. Cattle are sometimes poisoned, however, by browsing on the leaves.

Russian olive (5), an introduced plant useful for food and cover in wildlife plantings for erosion control.

Callicarpa americana *(6), used in the Southeast in wildlife plantings. Valuable for food and browse.*

Among shrubs, wild raspberries (8) are noted for their ability to grow on eroded soils and provide both food and cover for wildlife.

A Promising New Cedar for Erosion Control[1]

By Charles F. Swingle [2]

THE large-scale work in erosion control now under way has served to arouse interest in *Juniperus ashei*, the Ozark white cedar. Throughout much of the United States demands are insistent for extensive amounts of red cedar for planting on exposed areas where few other plants can survive. Due to the prevalence of the cedar apple rust (*Gymnosporangium Juniperi-virginianae* Sch.) and the widespread occurrence of both native and cultivated apples which serve as alternate hosts for this rust, it has been necessary either to ignore the rust on the one hand, with consequent risk both to the cedar trees themselves and to apple orchards in the vicinity, or on the other to substitute some otherwise less desirable plant for the proved red cedar. What is distinctly needed in a large part of the United States is a tree of the character of *J. virginiana*, but one immune to cedar apple rust.

Identification

In 1930, Buchholz [3] called attention to a new species of juniper which he named *Juniperus ashei*. He emphasized that it was of the same general type as *J. monosperma* (Engelm.) Sarg. though sufficiently distinct to warrant specific rank, that its occurrence was limited to a small area along the White River in northwestern Arkansas and southwestern Missouri, wholly out of the range of any other juniper except *J. virginiana*, and that it was immune to the cedar apple rust.

[1] This paper reports some of the observations made by the writer and other members of the Soil Conservation Service, particularly William Giles, Roger Sherman, and D. H. Foster. Thanks are also due to several other individuals both within the Soil Conservation Service and in other agencies and especially to Dr. D. M. Moore, professor of botany, University of Arkansas, and Mr. J. C. Dunegan, of the University of Arkansas and the Bureau of Plant Industry.

[2] Horticulturist, Section of Conservation Nurseries, Soil Conservation Service, Washington, D. C.

[3] Buchholz, John T. The Ozark White Cedar, Bot. Gaz., 90: 326–332.

Two points concerning the classification of the Ozark cedar can be stated rather definitely; first, it is unquestionably distinct from *J. virginiana*, the only other juniper of the region, and second, its nearest relatives are found hundreds of miles away from its limited range.

It is not entirely settled just what relationship *J. ashei* bears to *J. monosperma* and to *J. mexicana* Spreng. In his original description, Buchholz ignored *J. mexicana*, confining his comparisons to the similar *J. monosperma* and the distinct *J. virginiana*. The United States National Herbarium has no specimens of *J. mexicana* from the United States. The various specimens from Mexico show differences from *J. ashei*, particularly in size of seed.

Mattoon, Phillips, and Gibbs [4] showed *J. ashei* as occurring in Oklahoma. This is not an extension of the Ozark juniper across the line into northeastern Oklahoma, but refers to material from southwestern Oklahoma, doubtless much closer to the type of *J. mexicana* than is the Ozark material. In 1936, however, members of the Soil Conservation Service while scouting for other plant materials found this species in Mayes County, Okla. This is undoubtedly an extension of the previously known range of the Ozark form.

Palmer and Steyermark [5] are inclined toward accepting *J. mexicana* as the approved name for the Ozark cedar, though apparently with the idea that the individuals occurring in the Ozark region constitute a rather distinct geographic type. As emphasized by Buchholz, the Ozark cedar is wholly distinct in form from Eastern red cedar. The Ozark cedar usually branches at or near the base while the red cedar is almost invariably single-stemmed. The Ozark cedar (in common with *J. mexicana* and *J. monosperma*) displays under a magnification of ×20 or greater, some 30 to 50 or more fine serrations on each edge of each leaf, while the red cedar has entire leaves. Red cedar, as its name implies, shows more or less lively red in the heart wood, while in the Ozark cedar the heart wood is yellow or brown—never red. The Ozark cedar has the stiffer branchlets and when its leaves are crushed they emit a distinctly turpentiny and to most people much more pleasant odor than that which characterizes the red cedar leaves. When in fruit the Ozark cedar is readily and clearly distinguished from red cedar, the fruits of the former being in general about twice the size of the latter even though some 95 percent are one-seeded. The Ozark cedar fruits are much fleshier than those of red cedar and yield only about one-seventh of their total weight in clean seeds, as opposed to approximately one-fourth for red cedar.

Although the Ozark cedar occurs along the White River for some 150 miles, and is not at all rare in this region, probably throughout its limited range it is outnumbered 10 or more to 1 by the common red cedar. One of the sites with the largest individuals and the thickest stands is on the east bluffs of the North Fork of the White River, near Henderson, Ark. Many individuals here are 20 feet in height. Throughout the region of its occurrence it is variously referred to as white, yellow, or "Molly hairy" cedar.

[4] Mattoon, W. R., G. R. Phillips, and F. J. Gibbs, Forest Trees of Oklahoma, Oklahoma City, 1932.

[5] Palmer, E. G., and J. A. Steyermark, Plants of Missouri, Annals Missouri Bot. Gard. vol. 22, September 1935.

An example of the female tree as it occurs north of Lead Hill, Ark., near the Missouri line.

Resistance to Gymnosporangium Rusts

An outstanding characteristic is the entire absence of any cedar apple rust galls such as are usually abundant on red cedar trees throughout the Ozarks.

Buchholz stated that the Ozark cedar was immune to cedar apple rust. His basis for this statement was apparently wholly that of field observation. The present status of the question remains about the same—apparently no one has ever observed a single infection on this cedar growing under conditions which make for serious infection of the red cedar. Whatever the outcome of any future inoculation experiments, it seems proved that the Ozark cedar must have a very high degree of resistance to the type of Gymnosporangium so prevalent in the Ozark region. It is interesting to speculate as to just how much this immunity is based on its characteristic turpentiny oils.

How this cedar will react under other environments is yet to be proved. By analogy, however, considering the general uniformity with which red cedar is attacked

by the rust throughout its entire range, it does not seem too optimistic to expect that the Ozark cedar will prove, from the practical standpoint at least, to be completely immune to the cedar apple rust. This hope seems justifiable when one considers how its nearest relatives react. Arthur's Manual [6] lists three Gymnosporangium rusts which have been reported for *J. monosperma*, and one for *J. mexicana*. Of the former, neither *G. speciosum* Peck, nor *G. multiforum* Kern attack any members of the Rosaceae as alternate hosts. *G. nelsoni* Arth. apparently use various members of the Rosaceae as alternate hosts with juniper, but have never been reported on apple either wild or cultivated. *G. exiguum* Kern, the only rust reported for *J. mexicana*, affects Crataegus but apparently no other members of the Rosaceae. Hence apparently both *J. mexicana* and *J. monosperma* are free from all serious rust damage involving apples, and the hope that the Ozark cedar will continue to prove immune to the cedar apple rust seems to be well grounded.

Conservation Values

As suggested above, there is an insistent demand for a rust-free tree able to stand the extreme conditions of drought, heat, and cold which red cedar is so well able to combat. How does the Ozark cedar compare in this respect? As illustrated, it occurs naturally in some of the most extreme rocky ridges of the Ozarks. In very few places does it occur at all where there is enough soil for deciduous trees to gain a foothold. Uusally the Ozark cedar occurs with the red cedar at the crest of the hill, but the Ozark cedar does not follow the other as it moves down into the hardwood zone. The Ozark cedar is confined to the dolomitic and calcareous outcrops and bluffs in the western part of its range and to the sandstone outcrops and bluffs in the East.

Though it seems to occur naturally only on extreme rocky situations this is not because growth is impossible on better soils. Along with a number of others, the specimen shown was dug in the wild as a small seedling and planted on the university campus at Fayetteville 9 years ago. No exact measurements have been kept, but apparently the rate of growth of the Ozark cedars has been comparable to red cedars handled similarly at Fayetteville.

It seems obvious that the Ozark cedar is able to withstand heat, drought, and poor soil just as well as does red cedar, though the limited range of the former would lead one to suspect that it might be the more

A transplanted specimen of **Juniperus ashei** *on the campus of the University of Arkansas, Fayetteville*

critical of soil conditions, especially with regard to demanding a relatively high alkalinity.

As to cold resistance, about all that can be said now is that temperatures of —20° F. are not unknown where it occurs and that there are no evidences that winter injury has played any part in its sharply delimited range. Furthermore, 1-year seedlings in the nursery at Elsberry, Mo., went through the winter of 1936–37 with no indication of winter injury. In the spring of 1937 some of these seedling were sent to Soil Conservation nurseries in North Dakota, Washington, California, New Mexico, Colorado, North Carolina, and Ohio, and to Bureau of Plant Industry stations in Maryland and Wyoming, and it is hoped to have readings on hardiness in those States starting with the winter of 1937–38.

The two preceding paragraphs partially answer the questions regarding the value of this species in erosion

[6] Arthur, J. C. Manual of the Rusts in the United States and Canada. 1934.

work, for the ability of any species merely to live under the conditions where it grows is sufficient to insure its having some place in any large-scale erosion program.

Wood Qualities and Uses

The Ozark cedar, however, will do much more than merely live under extreme conditions. In the immediate area of its occurrence its wood is considered as valuable as, if not a trifle more so than that of red cedar. For example, Will Sharpe of Flippin, Ark., post buyer for the A. L. Budd Hardwood Company, handlers of large quantities of cedar posts, stated that he considers the Ozark white cedar a little better than the red cedar because its wood is harder and holds staples much better. Mr. Sharpe emphasized that the lasting quality of cedar posts is due almost wholly to the proportion of heartwood to sapwood, the color of the heartwood making little if any difference. The writer inquired at several places just outside the area where the Ozark cedar occurs and was told, "Yes, we have white cedar here, but it isn't nearly so good for posts as red cedar." On closer examination, however, it seemed that what was looked on as white cedar was really young *J. virginiana* with a high proportion of sapwood. Apparently the Ozark cedar is as variable as the red cedar in this matter of relative proportions of heartwood and sapwood.

Obviously the tendency of the Ozark cedar to branch close to the ground makes it not quite so desirable for post production as the erect-growing red cedar. In spite of its globular form, however, the Ozark cedar shows generally straight growth and ultimately each of the several framework branches makes a usable post. Certainly with a very slight amount of attention in the matter of pruning, it could be made to show a post yield per acre comparable to that of red cedar.

This branching tendency, as well as the somber color of the wood, definitely indicates that the Ozark cedar can hardly be expected to have much value as saw lumber.

Wildlife Value

Its spreading habit should contribute toward making the Ozark cedar a very desirable species for ground cover.

Furthermore its large fleshy fruits seem to be of considerably greater value as game food than the smaller and drier fruits of red cedar. This was especially emphasized in January 1937, when a large crop of Ozark cedar fruits completely disappeared within a few days following a heavy snow which put a premium on other bird food. The robins seem to be particularly fond of these fruits.

Natural reproduction is wholly by seeds. The exact conditions required for germination are not at all known at the present time. Seed of the 1934 crop harvested in the winter, allowed to dry and planted in April 1935 at the Elsberry, Mo., nursery of the Service, failed to germinate until the spring of 1936, when a very satisfactory stand was obtained.

There was no seed crop available for collection in the fall of 1935.

Seed of the 1936 crop, harvested in the winter and planted within a few days after the seed had been cleaned from the flesh, gave prompt germination in April 1937 at Manhattan, Kans., and elsewhere.

These somewhat divergent results are not at all surprising in view of similar erratic behavior frequently experienced with other junipers. In this connection it will be remembered that with reference to other junipers, Peck[7] found that the seed should be subjected for 100 days to a temperature of approximately 41° F. for after-ripening and germination. Following germination a temperature of approximately 60° F. seemed indicated.

Seeds of the Ozark cedar appear to be fully mature about the middle of November, after which time they can be readily shaken from the tree. Many of the fruits are found to have sterile seeds—some plants showing only 20 percent or even less plump seeds. It is interesting to note that under the same conditions red cedars show many worthless seeds.

Many tests made at the Elsberry nursery in the fall of 1935 indicated that even with bottom heat it is not easy to root cuttings of the species.

There seems to be no opportunity for any large-scale collection of wild seedlings, since they occur on such rocky sites and are always mixed with red cedar.

Summary

The Ozark white cedar seems promising for planting on extremely dry or rocky sites such as those where the eastern red cedar is indicated. It seems especially adapted to limestone soils. It has durable wood, furnishes good post material, is a highly-prized wildlife species and is apparently immune to the cedar apple rust.

The dollars-and-cents value of vegetative cover is clearly set forth in two articles soon to appear in Soil Conservation, in which are reviewed some recent experiences with debris basins.

[7] Peck, Dean A. After Ripening and Germination of Juniperus Seeds. Bot. Gaz. 71: 32–60. 1921.

by Walter V. Kell[1]

NEW LIFE FOR THE OLD FARM

This is the story of an eastern corn belt farm during the years from 1933 to 1937.

THE owner of the farm (he was called "Dad" by all who knew him) was beginning to show the results of long years of toil devoted to carving out his acres from the virgin wilderness. In fact, two farms had been subdued by him and left as monuments to his ceaseless toil. It had been no small task—the clearing of forests, breaking the stubborn, tough prairie sod for more corn, more potatoes, vegetables and wheat to feed the large family. Now there were no new farms to be put under the plow, and hard work and long hours were what it took to make a bare living off the old farm. Dad was getting tired. He spent a great deal of time in talking about the accomplishments of the past and in encouraging the boys to go ahead with the work which he had started when the country was new.

Thrift had been almost a religion with Dad. More-corn-to-feed-more-hogs-to-buy-more-land had been his theory. He had argued that each new acre put under the plow made the farm that much more valuable, and he could not understand that his theories did not appeal to the boys who were sizing up the old farm and secretly comparing the possibilities with those in neighboring fields where the pastures were greener.

To the boys it seemed that so many crops had been extracted from the old farm that very little was left of it. Certainly it would take more than long hours and hard work to obtain from those badly leached and faded acres anything remotely resembling the bounteous crops of the past. They were loyal, however, and they did not want to give up. They had heard of new farming methods, much talked about but not practiced by many farmers. Had Dad known about these methods and used them in the early days—but he hadn't, and now, looking over their bleached acres, the boys were skeptical. What could be done with such land? In spite of their skepticism they felt a keen interest in the new ideas and a strong desire to try them out on the old farm.

But the farm would no longer support the large family and two of the boys left. Fortunately they found jobs with the C. C. C. They all hoped that some outside money might keep the old home farm going for a few more years. The boys who stayed with the land worked harder than ever before to make up for the labor that had gone to the camp. There was no time now for the new ideas; every hour and every square foot of ground must be worked to produce the necessities of life.

But it was not long before a letter arrived from the boys in the camp, telling about their new jobs with the Government. The work was right down their alley. The Government had started a new program to prevent soil erosion. Soil erosion was responsible for the abandonment of many farms and, incidentally, for the low yields on the home farm. Their camp was assigned to this new soil-erosion control work, and although they did not as yet know much about the program, they thought it would be a good idea to do a a little experimenting on the old farm and, if the plan worked out, it could be used to advantage in encouraging neighboring farmers to join them in the experiments.

The two brothers who were at the camp wrote out some definite suggestions, the first having to do with a rearrangement of cropping plans into an improved rotation. Just why this was necessary they did not know; but they had noticed that cultivated crops such as corn or potatoes seemed to thrive more and show a darker green color following a hay crop, especially if the hay crop happened to be clover or some other legume, than when repeated year after year on the same ground. They recalled, too, that the last small patch of new ground on the old home farm did not wash as badly after plowing as other fields which had been in use for many years.

The boys on the farm were interested. They began observing the effects of different crops. They discovered that when sod ground was plowed it washed very little during the first year or two. They decided to find out the reason for this. They made inquiries here and there and learned that at Ithaca, N. Y., a soil-erosion experiment station had been established and that some of the experimental plats had been laid out on new ground—land freshly cleared from the forest.

After casting lots one of the boys made the trip to Ithaca to see the experiments. He learned that from the new land there was almost no loss of either rain or soil—and this regardless of the farming method used and even on rather steep slopes. Across the fence were contrasting plats, laid out on land that had been

[1] Senior Agronomist, Soil Conservation Service, Washington, D. C.

farmed for a number of years. There a great deal of rainfall was lost as run-off, and it carried with it large amounts of topsoil unless some obstruction, such as terracing or vegetation, was present to strain out the soil and hold it on the hillside. The boy from the old farm had learned a valuable lesson. He could understand now why Dad had not been interested in the new farming methods. Dad had begun farming with new land; he had developed his thoughts and his habits in terms of farming new land and, before he realized that there was such a thing as soil erosion, most of the topsoil had been washed from the slope down into the creek that drained the farm. The boy went home to describe what he had seen at the soil erosion experimental station.

The question was, What can we do to this land to restore its vitality, to prevent further serious erosion? And they went out to make a few investigations of their own. They found that on the newer land decaying plant roots were mixed through the soil and that its mechnical and physical condition was good. This soil had been the home of millions of earthworms and other living organisms. It had been protected by vegetation which had kept it alive and active throughout the long years. In other words, this new soil had life while the soil on the older fields seemed dead.

The boys recalled that throughout the long years the old fields of their farm had been planted to corn in the spring and cultivated all summer. The corn was harvested in the fall, and the soil lay bare until the next summer when another crop was planted. They knew now that if this continued it would not be long before the very life of the land would be irrevocably destroyed. They determined to correct some of the errors of the past.

The young farmers heard of an acreage down in Georgia, operated by R. L. Hardy, where some of these difficult problems had been solved. For the second time they cast lots and one of the brothers made the trip to visit Mr. Hardy, who lived near Senoia, and to walk over his entire farm with him. He found that Mr. Hardy was growing a mixture of crimson clover and rye grass which occupied the ground continuously except during the comparatively short season required for a corn or cotton crop. And, what was stranger still, not even during the crop season was all the field plowed for corn or cotton; for Mr. Hardy had learned that by leaving a small strip of unplowed land between each row (he called it the "balk system") his crimson clover and rye grass matured seed before it was time to do very much cultivating in his short-season crop. As soon as this seed was mature, Mr. Hardy explained, it would be covered rather deeply with the cultivator. It would then lie dormant until the end of the cultivating season when he would again work it up to the surface and allow it to start growth with the first late summer or early fall rains.

This cover crop, as Mr. Hardy called it, would not do much in the way of growth until the corn or cotton was almost mature. Then, as more sunlight reached the ground, the crimson clover and rye grass would take possession, covering every square inch of the soil until rows were again plowed for the next year's cash crop. Mr. Hardy had stands of crimson clover and rye grass that had been seeded 5, 6, and 7 years before, with no new seed being applied. All farming operations under Mr. Hardy's system were strictly on the contour. With the combination of dense growing vegetation and contour farming practices, rain water loss was minimized or eliminated and there was no sign of erosion on any of his fields. A portion of the crimson clover and rye grass was permitted to mature a seed crop for harvesting, in order that, should unusual weather conditions cause a failure of voluntary seeding, new seed would be at hand for the continuance of the system. There was always a good stock of seed on hand.

The young farmer went home to the old farm determined to imitate Mr. Hardy's practices. The brothers, once again viewing their bleached acres, discussed eagerly the problem of a cover crop; for they were convinced now, beyond all questioning, that it was necessary to keep the soil protected at all times when not engaged in producing clean-cultivated crops for harvesting. They were not sure that crimson clover and rye grass was the cover crop suitable to their land and climatic conditions. Another crop should be substituted. Rye, they decided, would be satisfactory, since it could be seeded over rather a wide range of dates even though the soil was fairly dry. Growth would start when the rains came. In favorable seasons rye would provide some pasture both in the fall and the spring, and, most important of all, rye would provide protection to their soils during those long months which previously had been so damaging.

Time passed and the old fields knew the comfort of protective cover. The young farmers soon discovered that by turning under a good cover crop the clean-cultivated crops responded more nearly as they would on new soils. They discovered also that soil wash was lessened. Another year passed, and a large field which had been protected by a cover crop over the winter,

"The plants were badly battered, many of them entirely washed out."

was plowed and planted to corn, the contour method being employed throughout all operations. The young farmers on the old farm were now using rotations, cover crops, and contour tillage—certainly, these practices would go a long way toward providing the big yields they hoped for.

The corn grew and was a beautiful sight with its long curving rows and its new plants evenly spaced over the entire field. They finished the first cultivation. It was about the middle of June. In the night a storm of cloudburst intensity broke, and rain pounded the roofs of the farmhouse. Several inches of rain fell within a few hours. The boys could not but wonder what was happening in their cornfield.

Early the next morning they started out. The hay field was bright and green with no damage whatsoever from the enormous amount of water that had fallen in so brief a time. They crossed the pasture where there was still enough water to ooze up around their shoe soles at each step, but the grass was in excellent condition. They were certain now that they would be provided with good pasture for a long time to come. The rain water was retained on the ground by the grass, it would sink into the soil gradually, be pumped out again as the grass needed it. The pasture soil was protected from washing.

The next field was the corn field. Here their hearts sank, for the plants were badly battered, many of them entirely washed out, and all depressions and low areas in the field were either washed to the gully stage or filled with water that would surely drown the corn. This was a serious blow. It was too late in the season for a second planting, and so much had depended on that year's crop.

The boys spent the morning lamenting the loss of their corn crop and the damage to that important field. To fill the gullies and level the field—the extra labor would mean a real expenditure to them. They could not afford it.

Soon another letter came from the C. C. C. workers. It told of producing crops in strips, to provide protection at all times for the clean-cultivated areas.

Why hadn't they thought of this before! There was the hay field which had received the 4-inch rain without even slight damage. Had they distributed the hay, in strips, alternately, through the corn field, they could have saved not only the corn crop but the field as well. This would not happen again.

It required 3 years to establish the contour strips properly, with sufficient dense vegetation in the control strips to provide the necessary protection. As an extra precaution, a diversion ditch was constructed across the slope above the strips to intercept surplus water from the drainage area above and empty it on the pasture where it could do no damage. In fact, the grass needed much more water through the summer months than was formerly available.

Later, the pasture itself presented a problem. In long dry periods the grass and soil became very dry so that when sudden heavy rains came the water ran off as from a pavement. A letter was sent posthaste to the camp boys. How can we hold the heavy summer rains on the pasture field? Soon there was the answer—contour furrows. Small contour furrows, spaced about every 4 feet, would do the trick. The water from those sudden heavy downpours couldn't go far without being trapped and held in the contour furrows. The soil, once moist, would absorb all the rain.

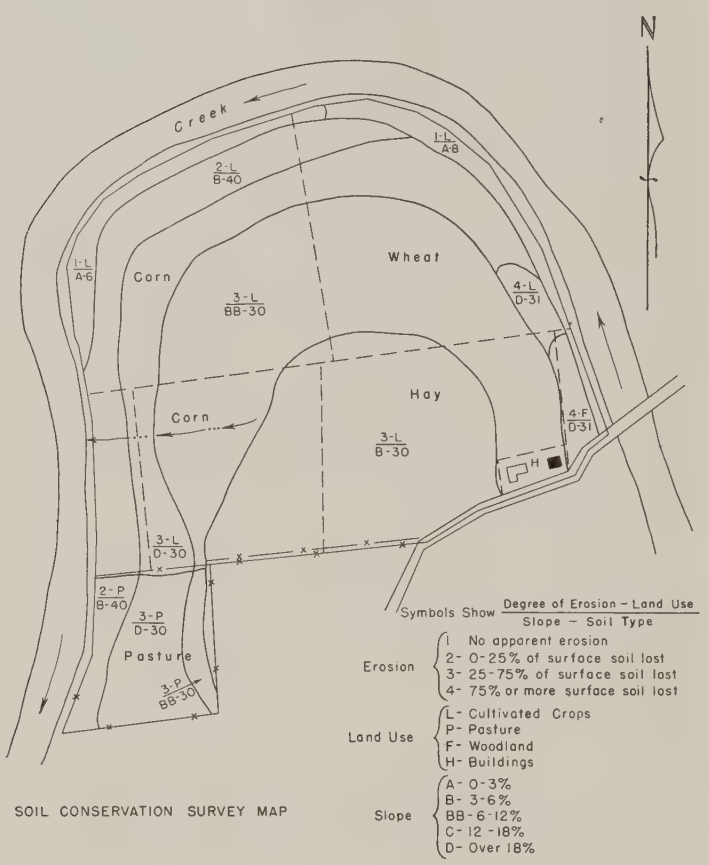
"The old farm was a good farm, after all."

The young farmers now could visualize a transformed farm with improved crops and pasture. Now they could afford to use fertilizers and to plow under a green manure crop occasionally and now not all their acreage was required for growing corn and potatoes. The acre yields were higher, and less acres meant more leisure. The old farm was a good farm, after all. It was a slow process, but the new ideas were producing results. (*Continued on p. 84*)

FARM PLANNING

Vegetative cover is a controlling factor, *says* H·C·Diener[1]

Figure 1.



SOIL CONSERVATION SURVEY MAP

THE Service has planned over 50,000 farms. The primary objectives are the control of soil erosion by wind and water, and moisture conservation. In planning a complete reorganization of the farm for soil and moisture conservation, the economics of a well-balanced farm program must have consideration at all times.

In planning the farm, the conservationist has a number of points to bear in mind, which may be divided into two general classes: (1) physical characteristics of the land and (2) economic influences. Some of the physical points are steepness of slopes, degree of erosion, erodibility of the soil, and vegetative cover. Among the economic factors influencing the plan are livestock units, feed requirements, efficient crop use, marketability of crops, land value in comparison with structural costs of control measures, and permanency of measures recommended.

The success of the plan in operation rests on the practicability and crop balance in the agronomic program, the efficient use and management of forest land, and the economy of the farm reorganization. The farm must be the unit for the plan and not particular fields as individual areas. Costs must be defrayed from the productiveness of the whole farm, according to the best land use decided upon by agronomists, foresters, engineers, and conservationists in accordance with the type of agriculture best adapted to that region.

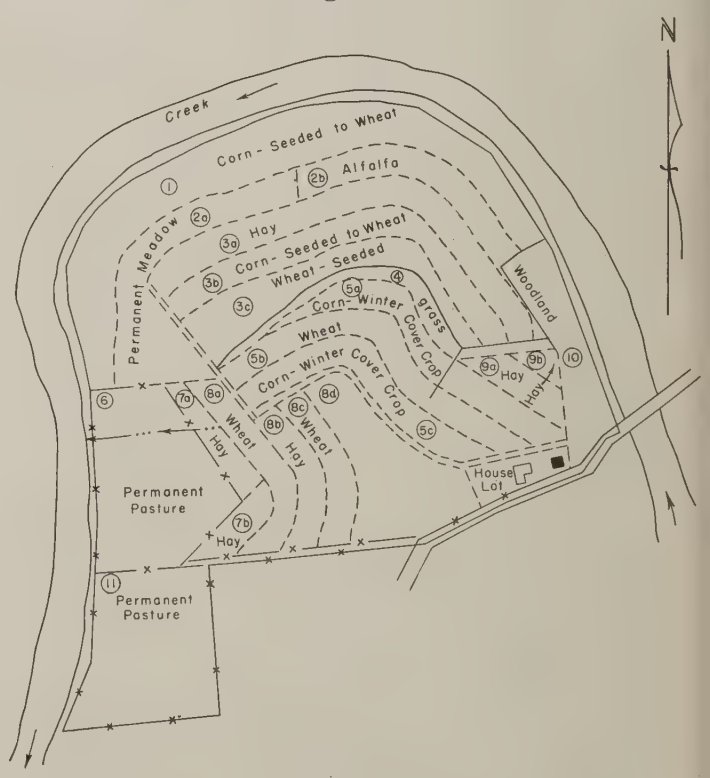
In many instances it may be desirable to make more radical changes in the methods of farming rather than the type of farming, especially in the older areas of the country where systems have been developed by long years of experience.

Representative Farms

Figure 1 represents a typical Pennsylvania farm of the general-purpose type, where almost one-half of the acreage has been devoted to the growing of clean-cultivated crops each year. A rotation of corn-corn-wheat-hay occupies four fields, selected for their similarity in size rather than in recognition of soil, slope, and the possibility of severe erosion.

Past practices have set up a square system of farming on curves and slopes of this farm, and erosion has taken its toll during the past years, as is evidenced by the physical land survey. The flat bottom land along the

Figure 2.



REVISED LAND USE MAP

[1] In Charge, Erosion-Control Practices, Soil Conservation Service, Williamsport, Pa.

creek shows very little erosion, but with increasing steepness of the slope there is more and more evidence that in a very few years, under present practices, a large area of this farm will have none of the topsoil remaining.

Technicians of the Soil Conservation Service, in planning a reorganization of this farm, as shown in figure 2, have kept in mind a yearly balance of crop needs, permanent vegetation on the steeper slopes, contour strip cropping on the lesser slopes, close growing cover crops on clean-cultivated areas during critical periods of erosion, and diversion of excess water on long slopes where vegetative cover was considered insufficient to control rapid run-off and erosional drainage.

The critical areas found in fields 2a and 2b, with slopes of 12 to 18 percent showing severe sheet erosion and some gullying when used for clean-cultivated crops, were removed from the regular rotation and put in permanent sod cover. Field 6 on a slope above 18 percent was retired to permanent pasture with fertility treatment to induce growth of a good vegetative cover. Field 11 on a similar slope, with more than 75 percent of the topsoil removed, was retired to forest, to give protection from erosion, increase woodland products on the farm, and afford wildlife cover. The remaining portion of the farm was laid out in contour strips, and a rotation was established to alternate a grass or close-growing grain crop with clean-cultivated crops.

First-year cultivated crops on fields 3a and 5c are followed by winter cover crops, and this practice will be adopted in future years on all areas having clean-cultivated crops.

At a point on the slope where run-off might cause erosion damage during the rotation, a water-intercepting channel was placed to carry this excess water gradually around the slope and down to lower levels through a vegetated outlet. A contour strip of permanent sod above the intercepting channel affords protection and filters silt from excess water originating on the upper slopes.

The reorganization of this farm has all fields on the contour of the land, and all farm operations follow level contours with economy in horsepower necessary to operate implements. The entire plan is one which might be placed in operation on thousands of farms throughout the country, with small additional costs above ordinary good farm practices. The program is based on sound economy and soil preservation for permanent agriculture.

Slope Usage

(*Continued from p. 67*)

income from wood and from home industries based on wood.

There are several trees now planted only for shade and street use that offer opportunities as high-priced specialty woods. The Empress tree, *Paulownia tomentosa*, grows rapidly and has good possibilities for figured veneer, furniture wood, and wood for many specialities, such as jewel caskets, waste-paper containers, and magazine racks. The Cedrela, or Chinese mahogany, and the Ginkgo offer other opportunities.

It requires little imagination to see that if man can live well on the very few plants he has sought to improve, then he surely can live better if he will seriously consider the possibilities in the tremendous number of unused plants at hand for similar improvement. Sufficient numbers of better than ordinary strains of trees, shrubs, and other long-lived crop plants are already available to start testing the hill-culture system of erosion-control farm management. But the real possibilities lie in directing research efforts toward finding and developing the many unexplored sources for better erosion-control plants and their improved uses for combined erosion-control and economic purposes. To this end, hill-culture research in the Soil Conservation Service works in full cooperation with the Bureau of Plant Industry and other plant research organizations of the Department, and with the State agricultural experiment stations, on selecting, testing, and improvement of hill-culture plants, products, and methods.

One of our plant-research cooperators recently remarked that when people hear about better grapes they immediately want them in hand for eating. It must be realized that overnight results are not to be expected of all that is attempted. Superior nut and fruit plants developed and tested by plant specialists are now available to landowners and control technicians at commercial nurseries, but the high cost involved in producing grafted stock tends to prevent its extensive use. As cheaper methods of vegetatively propagating plants are developed, these better plants

(*Continued on p. 84*)

BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

METHODS IN PLANT PHYSIOLOGY. By Dr. Walter E. Loomis and Dr. Charles A. Shull. New York and London. 1937.

Here is the newest laboratory manual and research handbook for the plant scientist. It is a large volume presenting in an organized single text the experimental approaches to plant physiology and the essential analytical techniques of routine investigations. Directions for laboratory experiments are accompanied by explanations of objectives underlying experimental operations, and each experiment is supplemented with a few highly pointed queries and citations to related literature.

Research methods in the physiology of the green plant are outlined and explained in minute detail, and tested laboratory experiments cover a wide range—from simple demonstrations for use in elementary classes in biology or botany to quantitative exercises requiring research technique and apparatus. Findings of leading English, American, and continental investigators are summarized making the volume of value to the student and worker in plant physiology, forestry, genetics, horticulture, and farm crops.

The two topics, growth and movement, are treated together for convenience—this because, in the words of the authors, "so many of the movements of plants are dependent upon changes in relative growth rates"; and such factors as food and water supply, light, temperature, oxygen, and auxins are treated by the experimental-query method. Fruiting and its effect upon growth is discussed under the chapter heading "Growth-Differentiation Balance and Growth Correlation." The authors have included throughout the laboratory series several experimental procedures not found in ordinary manuals. Of especial note are Heinicke's flowmeter method of gas analysis, the adaptation of Guthrie's color standard in Schertz's quantitative estimation of chlorophyll, and a unique technique for study of the "dark phase" reaction of photosynthesis. A generous list of micro-chemical tests on tissue sections is also given.

Part II of the large volume is devoted to general methods for routine chemical and physical experiments in plant physiology including a chapter on statistical methods by George W. Snedecor, and more than 30 ready reference tables of physical, chemical and mathematical constants commonly required for analytical work. Of particular note in this section of the book are the chemical procedures for ash, nitrogen, and lipid determinations. Useful techniques for quantitative studies of osmotic pressure, surface tension and specific conductivity are also given along with the principles involved in use of apparatus.

The plant scientist will recognize in this work a new departure in texts in that it combines within one volume a plant physiology laboratory manual, a quantitative physico-chemical analysis, a bio-statistical handbook and ready reference tables of physical constants for analytical procedures.

GRASS SEED

(*Continued from p. 72*)

the seed, in some instances, makes the task of collection from natural stands very difficult. The same facilities used for the production of seed of accessions from the observational nursery could be extended to the production of seed of native species that are now collected extensively from natural stands. It is believed that such a policy will do much to insure a dependable seed source and assist in stabilizing the grass program of the Service.

During the last two seasons the number of acres of nursery land devoted to the production of grass for seed increase purposes has been greatly enlarged. At present, regions 4, 6, 7, 8, 9, 10, and 11 are devoting certain of their nursery acreage to the production of grass seed, and the seed produced in this manner has relieved the nursery personnel from making such extensive quantity collections of seed from natural stands. Species of *Bouteloua*, *Andropogon*, *Buchloe*, *Panicum*, *Elymus*, *Bromus*, *Stipa* and *Agropyron* are being grown for increase purposes. Introductions of *Elymus*, *Hordeum*, *Agropyron* and *Eragrostis* are also being increased. A typical threshing scene of *Eragrostis curvula*, recently brought into cultivation and use for the first time in region 8, is shown.

A 15-acre planting of *Eragrostis curvula* on the nursery at Tucson, Ariz., gave a yield of 4,300 pounds of clean seed. This seed crop was mature about June 15. A second seed crop should mature in October if seasonal conditions are normal.

NEW LIFE FOR OLD FARM

(*Continued from p. 81*)

Dad isn't farming now, but he is looking on contentedly. The two camp boys are back home and together they have an option on an adjoining farm which they think will respond to the new ideas, provide profitable employment, and carry them nearer their goal. These boys are *farmers*.

SLOPE USAGE

(*Continued from p. 83*)

can be planted more extensively for erosion-control purposes. A still larger opportunity lies in new and highly specialized hill-culture plants developed through cooperative effort of all plant research agencies to effectuate the national erosion-control program. No plant miracles can be expected in such work; it calls for organized and well oriented research over a period of years.

U. S. GOVERNMENT PRINTING OFFICE: 1937

Vegetation Used In Erosion Control, Topic of Bulletins

For REFERENCE
Compiled by Mrs. ETTA G. ROGERS, Publications Unit

Field offices should submit requests on form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

Office of Information, United States Department of Agriculture

Shipmast Locust a Valuable Undescribed Variety of Robinia Pseudoacacia. Circular 379. January 1936.

Blue Grama Grass for Erosion Control and Range Reseeding in the Great Plains and a Method of Obtaining Seed in Large Lots. Circular 402. July 1936.

Slash Pine. Farmers' Bulletin 1256. Issued May 1922, revised June 1931.

The Windbreak as a Farm Asset. Farmers' Bulletin 1405. Issued January 1924, revised November 1936.

Nut-Tree Propagation. Farmers' Bulletin 1501. August 1926.

Cover Crops for Soil Conservation. Farmers' Bulletin 1758. July 1936.

Strip Cropping for Soil Conservation. Farmers' Bulletin 1776. June 1937.

Lespedeza. Leaflet 100. 1933.

White Clover. Leaflet 119. October 1936.

Water Utilization by Trees, with Special Reference to the Economic Forest Species of the North Temperate Zone. Miscellaneous Publication 257. June 1937.

Studies of the Culture and Certain Varieties of the Jerusalem Artichoke. Technical Bulletin 514. May 1936.

Types of Vegetation in the San Joaquin Valley of California and Their Relation to the Beet Leafhopper. Technical Bulletin 557. June 1937.

Agricultural Experiment Stations

Alfalfa in Ohio Farming. Bulletin 137. Agricultural College Extension Service, Ohio State University, Columbus, Ohio. March 1935.

Alfalfa on the Cut-Over Lands of Northern Idaho. Bulletin 169. Agricultural Experiment Station, Moscow, Idaho. March 1930.

Alfalfa-Timothy Hay for the Dairy Farm. Bulletin 538. Agricultural Experiment Station, Wooster, Ohio. August 1934.

Alfalfa-Seed Investigations in Utah. Bulletin 258. Agricultural Experiment Station, Logan, Utah. November 1935.

Artificial Reseeding of New Mexico Ranges. Bulletin 189. Agricultural Experiment Station, State College, N. Mex. February 1931.

Behavior of Legume Bacteria (Rhizobium) in Relation to Exchangeable Calcium and Hydrogen Ion Concentration of the Colloidal Fraction of the Soil. Research Bulletin 256. Agricultural Experiment Station, Columbia, Mo. May 1937.

Better Pastures. Extension Circular 199. Extension Service, University of New Hampshire, Durham, N. H. February 1937.

A Comparison of Alfalfa, Sweet Clover, and Sudan Grass as Pasture Crops for Dairy Cows. Bulletin 265. Agricultural Experiment Station, Brookings, S. Dak. September 1931.

Composition of Soybean Plants at Various Growth Stages as Related to Their Rate of Decomposition and Use as Green Manure. Research Bulletin 173. Agricultural Experiment Station, Columbia, Mo. September 1932.

Crested Wheat Grass. Pamphlet 157—New Series. Department of Agriculture, Dominion of Canada, Ottawa, Canada. 1934.

Crested Wheat Grass for Dryland Pastures. Press Bulletin 84. Agricultural Experiment Station, Fort Collins, Colo. February 1935.

Crested Wheatgrass in Montana: Comparisons with Slender Wheatgrass and Brome Grass. Bulletin 323. Agricultural Experiment Station, Bozeman, Mont. June 1936.

Experiments with Legume Crops Under Irrigation. Bulletin 94. Agricultural Experiment Station, Moscow, Idaho. January 1917.

Kudzu. Bulletin 356. Extension Service, University of Georgia, Athens, Ga. April 1935.

Kudzu in Alabama. Circular 57. Agricultural Experiment Station, Auburn, Ala. January 1931.

Lespedeza in North Carolina. (Revised) Extension Circular 195. Extension Service, North Carolina State College of Agriculture and Engineering, State College Station, Raleigh, N. C. February 1937.

Lespedeza Sericea. Bulletin 154. Agricultural Experiment Station, Knoxville, Tenn. February 1935.

Occurrence of Selenium and Seleniferous Vegetation in Wyoming. Bulletin 221. Agricultural Experiment Station, Laramie, Wyo. May 1937.

The Place of Annual Legumes in the Cropping System of the Semi-Arid High Plains. Panhandle Bulletin 25. Panhandle Agricultural Experiment Station, Goodwell, Okla. March 1931.

Relative Efficiency of Roots and Tops of Plants in Protecting the Soil from Erosion. Bulletin 12. Conservation Department, Conservation and Survey Division, University of Nebraska, Lincoln, Nebr. January 1936.

Slash Pine for Reforestation in the Coastal Plain. Circular 41. Agricultural Experiment Station, Clemson College, S. C. August 1930.

Soybeans in Pennsylvania. Leaflet 36. Agricultural Experiment Station, State College, Pa. November 1935.

A Study of the Relative Adaptation of Certain Varieties of Soybeans. Research Bulletin 255. Agricultural Experiment Station, Columbia, Mo. May 1937.

Sweet Clover in Missouri. Circular 329. Agricultural Extension Service, University of Missouri, Columbia, Mo. October 1935.

Winter Grain Pasture Yield and Utilization. Panhandle Bulletin 26. Panhandle Agricultural Experiment Station, Goodwell, Okla. April 1931.

Superintendent of Documents, United States Government Printing Office

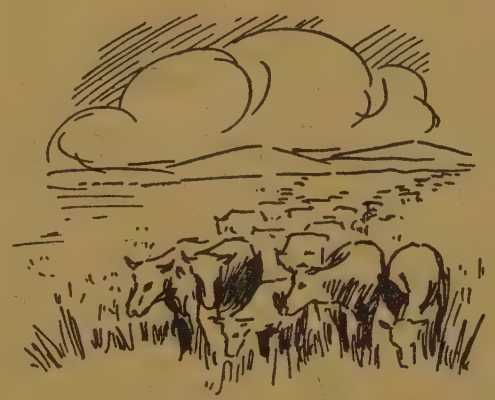
Range Plant Handbook. Prepared by Forest Service, U. S. Department of Agriculture. March 1937. $2.50 per copy, clothbound.

NOTE.—Additional references on vegetation for erosion control are listed in earlier issues of SOIL CONSERVATION. Particular attention is directed to volume II, no. 1, the list under the heading "Publications relating to pastures."

NATIVE GRASSES IN THE PACIFIC NORTHWEST

Grasses afforded protection for ages while the soil built up.

Early pioneers found bunch-grasses saddle-stirrup high and no erosion.

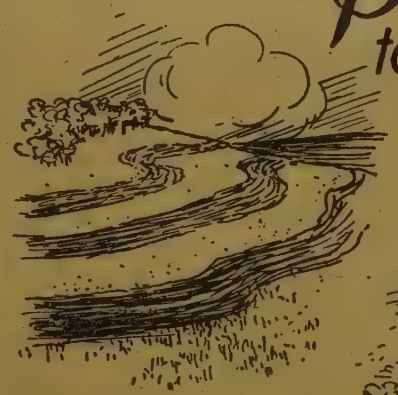


Plowing and overgrazing followed, and grasses began to disappear.

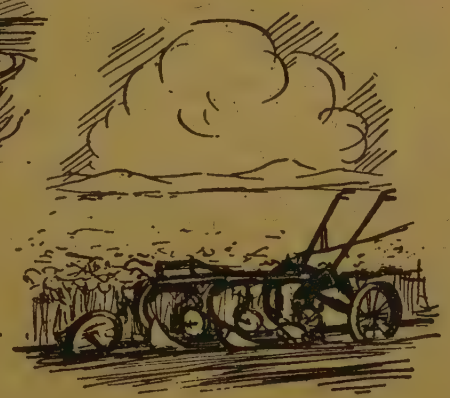
Until

Now some grasses can only be found along fences, roadsides and in old cemeteries.

But The Soil Conservation Service is now advising the farmers of the Pacific Northwest to turn once more to grass and cover crops as a conservation measure



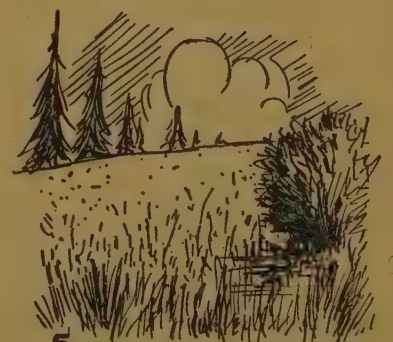
1 Rotation with soil-binding crops.



2 Turning under crops of green manure.

3 Careful utilization of residues from harvested crops.

4 Returning badly eroded lands to permanent cover crops.



5 Making abundant use of native grass, shrubs and trees.

Editor's Note.—The above presentation was suggested by the new Farmers' Bulletin No. 1773, "Soil and Water Conservation in the Pacific Northwest", written by E. M. Rowalt, of the Soil Conservation Service, in collaboration with subject-matter specialists

OIL CONSERVATION

FFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
NITED STATES DEPARTMENT OF AGRICULTURE · WASHINGTON

OCTOBER - 1937

Contents

	Page
The Hydrologic Cycle Re-Examined: *By C. W. Thornthwaite*	85
In-Place Lysimeters Near Coshocton, Ohio: *By Walter Urban Garstka*	91
Protecting Bottomlands from Erosional Debris: A Case History: *By Carl B. Brown*	93
The Bermuda Grass King: *By Angus McDonald*	97
A Border for the Woods: *By William R. Van Dersal*	99
Forest Destruction and Soil Erosion in Madagascar: *By Charles F. Swingle*	102
Post-War Agriculture and Soil Erosion in Czechoslovakia: *By Guy R. Stewart*	104
Contour Furrows Constructed Without Loss of Sod: *By Merle W. Bloom*	105
Opportunities for the Contour Balk Method: *By B. H. Hendrickson*	107
The "Spread Row" System for Laying Off Rows: *By B. L. Taylor*	108
Control of Soil Drifting in Canadian West: *By A. H. Joel*	111
Soil-Erosion Problems on Irrigated Farm Land: *By Dana F. Kirkmire*	112
Articles on Flood Control and Reservoir Studies	114
Introduced Plants in Erosion Control	115
Book Reviews and Abstracts: *By Phoebe O'Neall Faris*	116
For Reference: *Compiled by Mrs. Etta G. Rogers*	Opposite 116

Soil Conservation is issued monthly by Soil Conservation Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. Soil Conservation seeks to supply to workers and cooperators of the Department of Agriculture engaged in soil conservation activities, information of especial help to them in the performance of their duties, and is issued to them free by law. Others may obtain copies from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of $1.00 per year, domestic; $1.40 per year, foreign. Postage stamps will not be accepted in payment.

WELLINGTON BRINK
EDITOR

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

H. H. BENNETT
Chief, Soil Conservation Service

VOL. III • NO. 4

OCTOBER • 1937

ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON

The currents of the upper air are invisible, and they leave behind them no landmarks to record their track. We know not whence they come or whither they go. We have a certain rapidly increasing acquaintance with the laws of general atmospheric motion, but of the origin and limits, the beginning and end of that motion, as it manifests itself at any particular time and place, we know nothing. We cannot say where or when the vapor, exhaled today from the lake on which we float, will be condensed and fall; whether it will waste itself on a barren desert, refresh upland pastures, descend in snow on Alpine heights, or contribute to swell a distant torrent which shall lay waste square miles of fertile corn land; nor do we know whether the rain which feeds our brooklets is due to the transpiration from a neighboring forest or to the evaporation from a far-off sea.[1]

IN THESE words, one of the most literary of the geographers of the nineteenth century summarized the state of existing knowledge concerning the hydrologic cycle. The source of the moisture which appears as precipitation in an area and the ultimate disposition of that portion which is re-evaporated has been a subject of scientific concern for centuries. This question is not one of academic interest alone but has an important bearing on a number of beliefs which have exerted a powerful influence on scientific as well as popular thinking. Marsh,[2] in referring to the belief that vegetation and precipitation are reciprocally necessary to each other, quotes the following:

> Afric's barren sand,
> Where nought can grow, because it raineth not,
> And where no rain can fall to bless the land,
> Because nought grows there.

The idea that vegetation influences rainfall, in fact determines its amount and distribution, is so firmly rooted that it has been the basis of many action programs. In our country the Timber Culture Act of 1873 was passed in the belief that if the western farmers were induced to plant trees rainfall would be increased sufficiently to eliminate the climatic hazards to agriculture.[3] This belief still persists among some of these western farmers. During the current drought more than one has blamed his difficulties on his own failure to plant trees.

The same idea has reappeared in many forms. Aughey,[4] writing of Nebraska in 1880, credited the increased rainfall then being experienced to the spread of cultivation. He said—

> It is the great increase in absorptive power of the soil, wrought by cultivation, that has caused, and continues to cause an increasing rainfall in the State * * * . After the soil is "broken", a rain as it falls is absorbed by the soil like a huge sponge. The soil gives this absorbed moisture slowly back to the atmosphere by evaporation. Thus year by year as cultivation of the soil is extended, more of the rain that falls is absorbed and retained to be given off by evaporation or to produce springs. This, of course, must give increasing moisture and rainfall.

A long drought period setting in shortly thereafter, while Nebraska was still being settled, demonstrated the fallacy of Aughey's hypothesis, but apparently failed to lead to a critical examination of its premises. In a publication released this year, Clements,[5] in describing an investigation to determine the relative moisture contributions to the atmosphere from native grasslands and field crops as sources of moisture for local rainfall, conducted by Weaver and himself in 1923, says:

> The outcome demonstrated that there was no material difference in transpiration and evaporation from the two types of cover, and hence that cultivation could have had no favorable influence upon precipitation.

[1] Marsh, G. P. Man and Nature; or, Physical Geography as Modified by Human Action. New York, 1864. p. 183.

[2] Marsh, G. P. Man and Nature; or, Physical Geography as Modified by Human Action. New York, 1864. p. 182.

[3] Thornthwaite, C. W. The Great Plains. In Migration and Economic Opportunity. Philadelphia, 1936. p. 209.

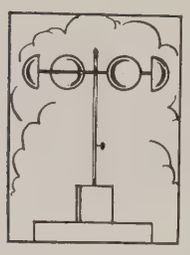
[4] Aughey, S. Sketches of the Physical Geography and Geology of Nebraska. Omaha, Nebr. 1880. pp. 44-45.

[5] Clements, F. E., and Chaney, R. W. Environment and Life in the Great Plains. Washington, D. C. 1937. (Carnegie Inst. Supp. Pub. 24.) p. 41.

By C. W. Thornthwaite — Head, Section of Climatic and Physiographic Research, Division of Research, Soil Conservation Service, Washington, D. C.

THE HYDROLOGIC CYCLE RE-EXAMINED

17389—37——1



There is no question that various types of vegetation and land use do contribute varying amounts of water to the atmosphere. A great mass of experimental evidence demonstrates this, but there is no similar demonstration that the moisture added to the atmosphere in this way is reprecipitated later in the same area. This is a matter which can be settled only when the sources of moisture for precipitation are known.

It is true, as Marsh said, that the currents of the upper air are invisible and that they leave behind them no landmarks to record their track. Of course, there are well-known exceptions, such as the transport around the world of volcanic dust from the explosion of Krakatoa in 1883 and the movement of dust from the Sahara to southern and central Europe. In recent years dust from the Great Plains reaching the Eastern States and the Atlantic has given further evidence on the direction and rate of air flow. However, such casual observations of dust in the atmosphere give only meager information about the movement of air currents and the transport of water vapor.

To answer the puzzling question about the source of moisture for precipitation, hydrologists have sought other evidence. Patient observation had indicated that the amount of water precipitated upon the lands exceeds that which runs off. Still the water level of the sea has not been lowered a measurable amount in historic time. Therefore, it is argued, the sea must contribute to continental precipitation only that portion which later runs off on the surface and underground; the remaining precipitation must be due to continental evaporation, and this being true, any means of increasing continental evaporation will result in increased rainfall.

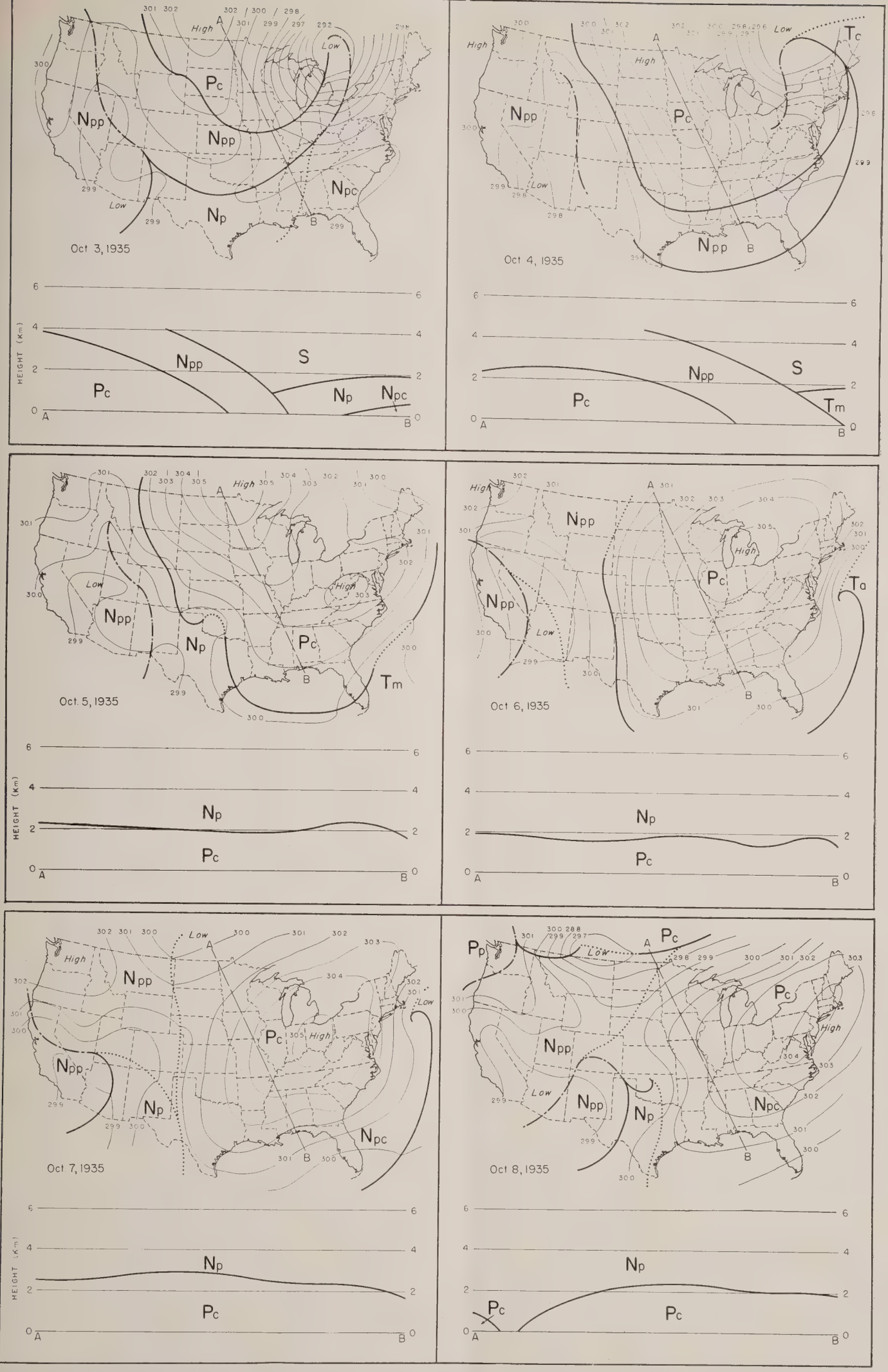
It is clear that a constant sea level demonstrates a hydrologic balance between the amount of moisture received from the sea by the land and that returned to the sea. It is also clear since water does not run up hill that moisture reaches the continents from the oceans only through the atmosphere. But there is no indication that water returns to the ocean only by flowing downhill as surface run-off. Gravity moves water in one direction only from land to sea. But gravity does not have the same control over the movement of atmospheric currents, and it is not unreasonable to suspect that if water vapor is transferred from the ocean to the land by the wind, it would also be transferred from land to ocean by the same means.

Records of run-off from lands to oceans and of precipitation on lands are considered to be sufficiently reliable to indicate their relative proportions. It is estimated that for the United States less than 30 percent of the moisture which falls as precipitation runs off the land and reaches the ocean. It may be argued that the continental moisture is transferred to the ocean only as run-off, and that since the ocean levels are constant less than 30 percent of the precipitation has a marine origin and the remainder represents reprecipitation from continental evaporation. It may be argued equally well that all of the precipitation is of marine origin, and that, since less than 30 percent runs off in streams and as underground flow, more than 70 percent must return to the ocean as water vapor. Thus, the disparity between the amount of water which falls upon a continent as rain and that which runs off from it to the ocean is in no sense an indication of the source of the precipitated moisture. We must seek elsewhere for the answer to this puzzling question. A provisional answer comes from a most unexpected source:

For several years a diligent group of meteorologists in Norway, using the meager data at their disposal have been furthering a revolutionary meteorologic idea. They maintain that the atmospheric circulation of the middle latitudes is due to the interaction of huge masses of air which are developed over so-called source regions and have uniform physical properties characteristic of the source regions.

Early each morning for the last 2 years, airplanes have taken off from the airport of a number of American and Canadian cities and have ascended to heights of 3 or 4 miles carrying delicate meteorological instruments for determining the characteristics of the upper air. In this way it has been possible to determine the temperature, pressure, and moisture content at various levels aloft. In addition, pilot balloon runs determine the velocity and direction of movement of the air. These observations verify the conclusions which had previously been made on the basis of occasional and unrelated kite soundings of the upper air in our country and prove the correctness of the concept of air masses.

It has been found that huge masses of air of great depth develop uniform physical properties over a



Invasion of Polar Continental air October 3-8, 1935. The 8 a. m. position of surface fronts. Cross sections from Canadian border to Gulf of Mexico show changing upper air relations of the air masses. KEY: Pp, Polar Pacific air; Pc, Polar Continental air; S, Superior air; Ta, Tropical Atlantic air; Tm, Tropical Maritime air; N, transitional type; solid line, cold front; dotted line, warm front; dash line, clouded front.

number of source regions in North America. The outward movement of the air from these centers, and the interaction of different types of air masses, are chiefly responsible for the weather of the continent. Several types of air masses are involved. The Polar Continental air, which is uniformly cold, dry, and heavy, forms over the vast Arctic tundra of northern Canada. The north Pacific Ocean is the source region for the characteristically cold and moist Polar Pacific air. Both masses generally move in a southeasterly direction across the continent and may encounter northward-moving Tropical Atlantic air masses, which are warm, very moist, and light. Tropical Atlantic air develops its characteristics over the Gulf of Mexico and the region lying between Bermuda and the Bahamas. The other types of air masses, not being essential to this discussion, are not described.

When the Polar Continental air pushes out from its source region and flows southward and eastward across Canada and into the United States and thence south and southeastward, it usually collides all along its route with the lighter and moister air advancing from the Gulf or from the Atlantic, which being lighter, is forced to ascend and yield moisture by precipitation. Most of the rainfall of eastern North America is caused by the interaction of these air masses. The storms which produced the floods of the Ohio and Mississippi during January of this year were caused by the ascension of Tropical Atlantic air over Polar Continental. The line of contact or boundary between the air bodies became temporarily stationary over the Ohio Valley, resulting in heavy rainfall as long as such conditions prevailed.[6] [7]

Observations of the upper air were initiated chiefly as an aid to improved weather forecasting. They have in addition, however, supplied a method for determining the sources of moisture. Although air is invisible, the air masses possess certain properties by which it is possible to trace their movements across the country. The Weather Bureau has recently established an Air Mass Division, where the "soundings" are analyzed and the pecularities of temperature, specific humidity, and pressure of each air mass are determined and where daily maps showing the position of the various air masses and their "fronts" are made.

The upper air observations make it possible to determine daily the total amount of water vapor in the air at the stations where soundings are made. Knowing the direction and rate of movement of the various air masses it is possible to determine which air masses lose and which gain moisture as they cross the country.

Benjamin Holzman,[8] of the Division of Research, Soil Conservation Service, has utilized the available upper air soundings in developing a method for locating the sources of moisture for precipitation. He has summarized a portion of his study in the Transactions of the American Geophysical Union as follows:[9]

> Polar air masses advancing equatorward absorb moisture by evaporation, become heated, and are eventually transformed into warm, moist, tropical air masses. Tropical air masses on the other hand, traveling poleward, precipitate most of their moisture, become cooled, and are ultimately transformed into cold, dry, polar air masses. This air mass cycle which is manifestly an expression of the general circulation of the atmosphere is closely associated with the balance of water over continental areas or, as is better known, the hydrologic cycle. In the cycle of air mass transformation it is apparent that moist, tropical maritime air bodies must rid themselves of their high water vapor content before they can ultimately be modified into polar air masses, and similarly polar air masses must gain in moisture before they can properly be transformed into tropical maritime air masses. Thus, in the alternating inundations of extensive bodies of air of different origin can be distinguished two principal classes, those that are losing their moisture and consequently contribute the major portion of precipitation on the earth and those that are absorbing moisture and constitute the greatest robbers of moisture from continental areas.

Mr. Holzman determined the gain or loss of moisture during the passage of a number of carefully selected air masses across the country. He also used the average values of properties of Polar Continental and Tropical Atlantic air masses and computed the gain of moisture to the first and loss from the second. He found the total water content of Polar Continental air at Ellendale, N. Dak., to be the equivalent of 0.44 inches of rainfall and at Pensacola, Fla., to be 0.97 inches. In traveling from the Canadian border to the Gulf these air masses absorbed 0.53 inches. The water content of Tropical Atlantic air at Pensacola was equivalent to 1.67 inches of rainfall and at Ellendale 1.01 inches. The journey northward resulted in a net loss of 0.66 inches of water.

Mr. Holzman recognized that the polar air gained 20 percent less moisture than the tropical air lost. This value, he cautiously suggests, would indicate the percentage of precipitation available for run-off if these two air-mass types were the only ones concerned.

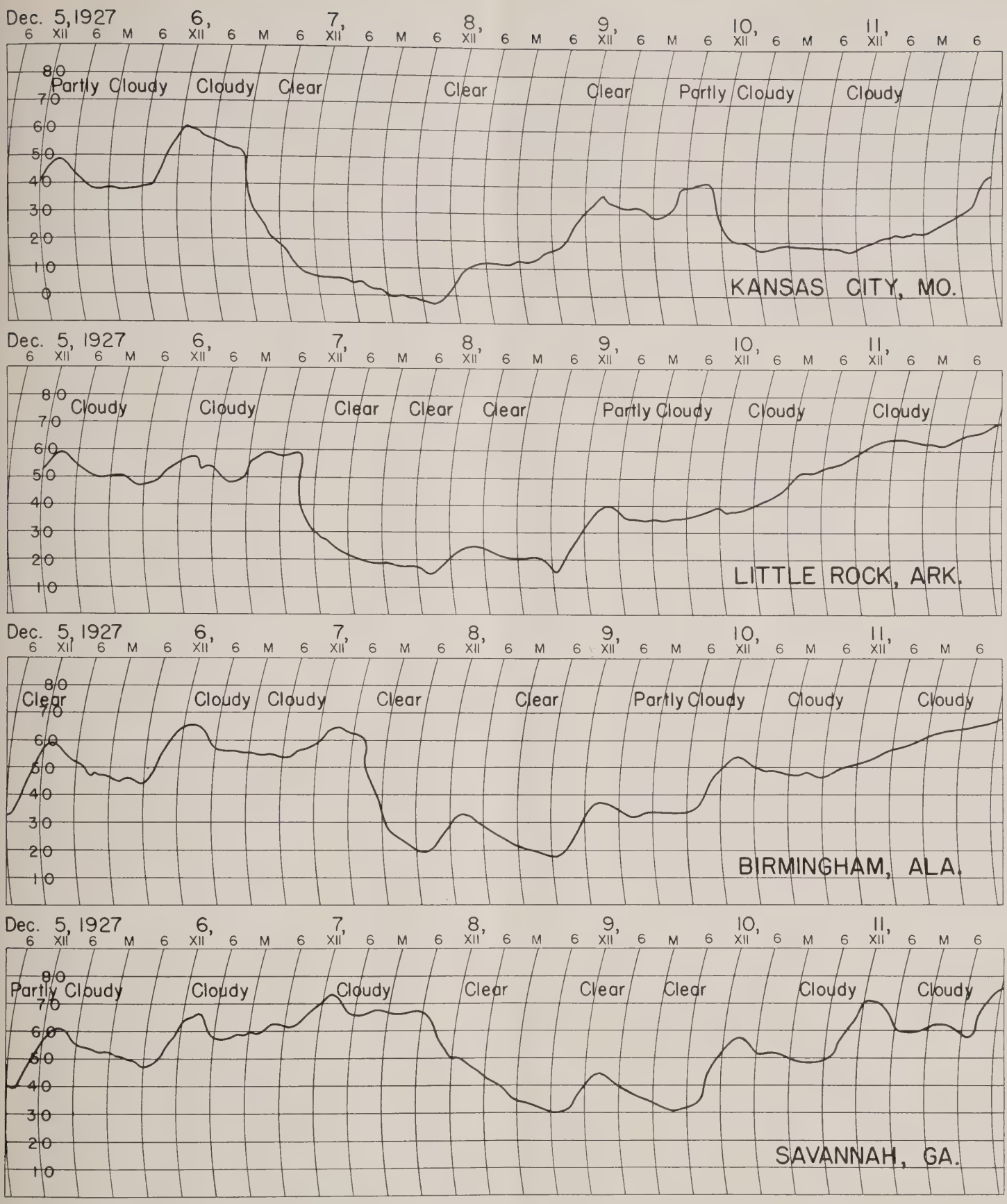
Hydrologists have been inclined to view the hydrologic cycle from below, commencing with run-off. It now appears that we might do well to view it from

[6] Thornthwaite, C. W. Climatic Studies and Canadian-American Relations. Conf. on Canadian-American Aff. Proc. 1937. (In press.)

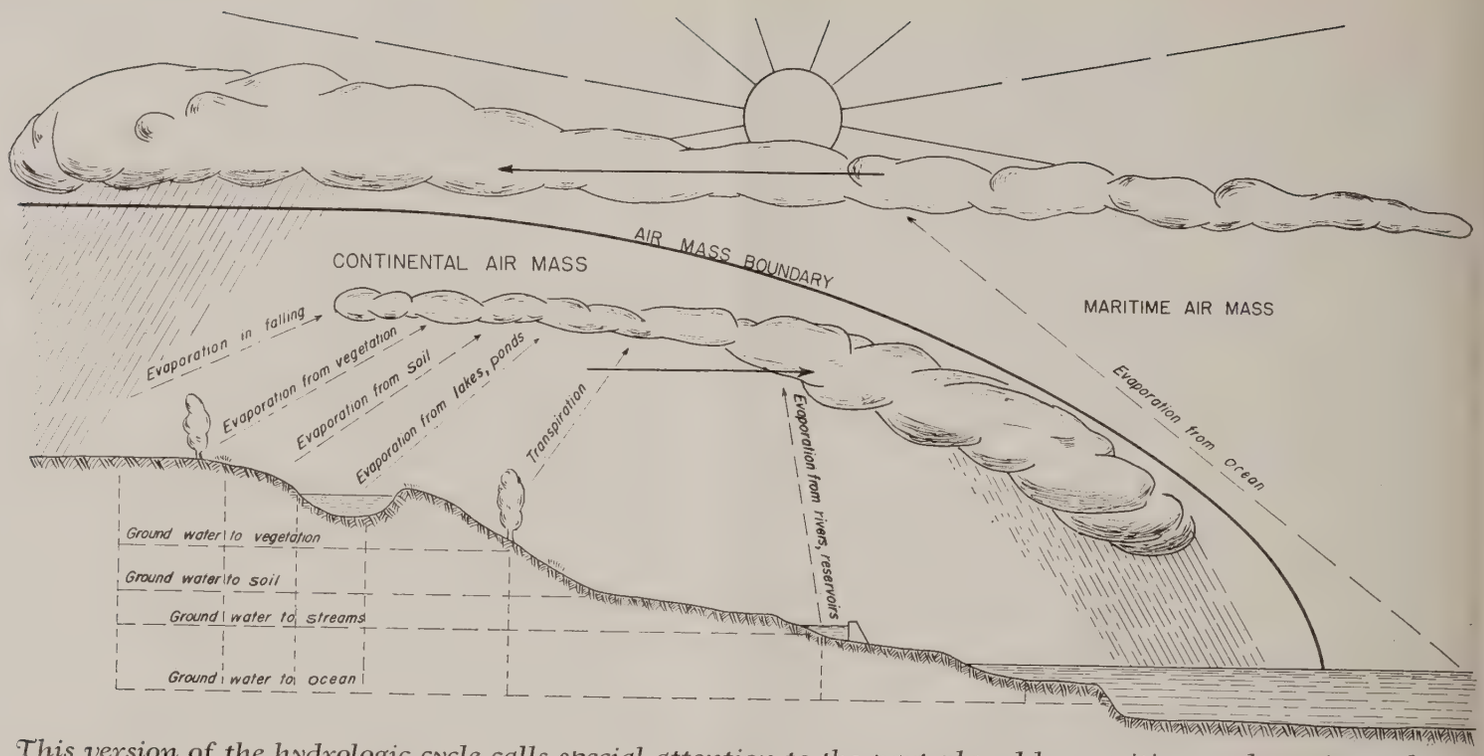
[7] Holzman, B., and Clarke-Hafstad, K. Changes in Atmospheric Circulation Result in Floods. Soil Conserv. 2 (11): 254–255, 266. 1937.

[8] Holzman, B. Sources of Moisture for Precipitation for the United States. U. S. Dept. Agr. Tech. Bull. 589.

[9] Holzman, B. Use of Aerological Soundings in Determining the Source of Moisture for Precipitation. Amer. Geophys. Union Proc. 1937. (In press.)



When a Polar Continental air mass comes out of the north and flows across the United States, it leaves an unmistakable record on every thermograph chart. The charts reproduced here show that the "front" passed Kansas City at 11 p. m., December 6; Little Rock at 9 a. m., December 7; Birmingham at 8 p. m. on the 7th; and Savannah at 7 a. m. on the 8th. The temperature at Kansas City dropped continuously from 53° above to 4° below zero Fahrenheit during the 33 hours following the frontal passage. At Savannah the temperature drop was from 66° F. to 30° F. in 26 consecutive hours. Although the air mass was modified at Savannah, it was still unmistakable.



This version of the hydrologic cycle calls special attention to the part played by maritime and continental air masses in the transport of moisture to and from the continent. It indicates that some moisture reaches the sea as surface run-off and underground flow, and that some returns in the continental air masses.

above, commencing with atmospheric circulation. By so doing, we observe two types of air masses: The first, warm and moist, being cooled and consequently losing moisture by condensation and precipitation; the second, cold and dry, being warmed and gaining moisture through evaporation. The run-off from a large drainage basin can be thought of as an expression of the relative effectiveness of these air-mass types. If the moist masses lose more moisture than the dry masses gain, there will be run-off. If, on the other hand, absorption by dry masses equals precipitation, there will be no run-off.

The consideration of the hydrologic cycle from the standpoint of air masses reveals an important omission from all existing diagrams illustrating its operation. They indicate that moisture evaporates from the oceans and is transported by the wind to the continents where it is precipitated. From there the course of the water is traced. Some is re-evaporated into the air; some returns to the oceans by way of rivers and underground waterflow; but nowhere is there recognition of the fact that any portion of the moisture evaporated from the land is transported by the wind back to the oceans. The diagram which accompanies this article does not cover all the details of the water cycle, but it does indicate the important phases. Moisture evaporated from the land may be reprecipitated over land areas; but since this source does not compare with the oceanic source, it is not shown on the diagram. Likewise the maritime air masses do absorb some of the moisture evaporated from the land, but for the sake of simplicity this is omitted. The fact that the moisture content of the maritime air masses eventually diminishes as they proceed across the land indicates that they are not receiving any significant quantities of water from the land. However, this is a question still to be examined. The records of a few automatic evaporation pans should be analyzed with reference to the succession of air masses. In this way we can determine what happens to evaporated moisture.

The consideration of the bearing of air masses on the hydrologic cycle suggests the need of further fundamental research. The preliminary findings of Holzman indicate that the principal source of moisture for precipitation on the land is the ocean, and that continental evaporation as a source of local precipitation is relatively insignificant. They suggest that changes in vegetation cover or land use, although not denying an influence on evaporation, will not increase or decrease precipitation in any measurable amount.

Polar Continental air bodies, being heavy, flow along the surface and, except where greatly modified, are easy to trace. A characteristic manifestation of the passage of a polar front is the abrupt, even precipitous, drop in temperature and rapid rise in pressure. The rate of movement varies, but seldom does it take more than 3 days for a front to advance from North Dakota to the Gulf or the South Atlantic coast.[10]

[10] Thornthwaite, C. W. The Polar Front in the Interpretation and Prediction of Oklahoma Weather. Proc. Okla. Acad. Sci. Vol. 9, 1929. pp. 93–99.

Assuming that the polar air requires 3 days for its passage and that it absorbs the average amount of water, 0.53 inches, as indicated above, the actual water removal from an area the size of the Mississippi drainage basin become tremendous. It reaches the astonishing rate of 5,909,000 cubic feet per second, which is more than nine times the average discharge of the Mississippi River. During the Polar Continental invasion of October 3 to 5, 1935, the total moisture in the lower 1,500 meters at Fargo was equivalent on the 3d to 0.12 inches of rainfall. Two days later at Pensacola the same air column had a moisture content equivalent to 0.38 inches. This air mass absorbed 0.26 inches of moisture in approximately 48 hours, which, if representative of the entire Mississippi Basin, would represent a discharge of 4,348,000 cubic feet per second, still more than seven times the average discharge of the Mississippi River, and nearly one and one-half times the maximum flood flow of record.

The Polar Continental air masses which flow from the Canadian Prairies southward and southeastward across the continent to the Gulf and to the Atlantic are in effect great invisible rivers transporting water from the land to the sea at rates apparently vastly greater than those of the surface drainage.

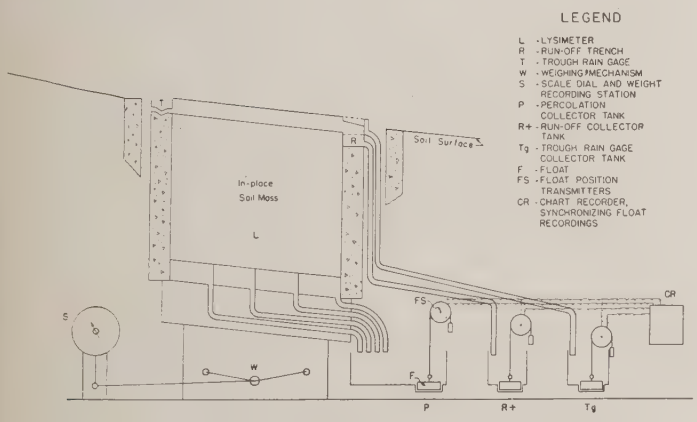
This suggests a novel method of flood control. It would seem that any method of soil conservation or of forestry which would retard the run-off in the headwaters area of a drainage basin would increase the evaporation opportunity of the water. In this way more of the water would be diverted from the surface streams into these great invisible atmospheric streams. Any technique which would stimulate additional evaporation of excessive rainfall from the land into these atmospheric streams, there to be conducted harmlessly back to the seas, would serve as an important and supplemental flood-protection measure.

It should be understood that the foregoing flood-control suggestions still lie within the realm of theory. It is clear that if they were to work they would have tremendous possibilities. For that reason, it is hoped that this article will stimulate open-minded discussion and argument as well as further investigation from which should come greater appreciation of the interdependence of meteorology and hydrology, if nothing more.

In-Place Lysimeters Near Coshocton, Ohio

By Walter Urban Garstka [1]

WATERCYCLE LYSIMETER

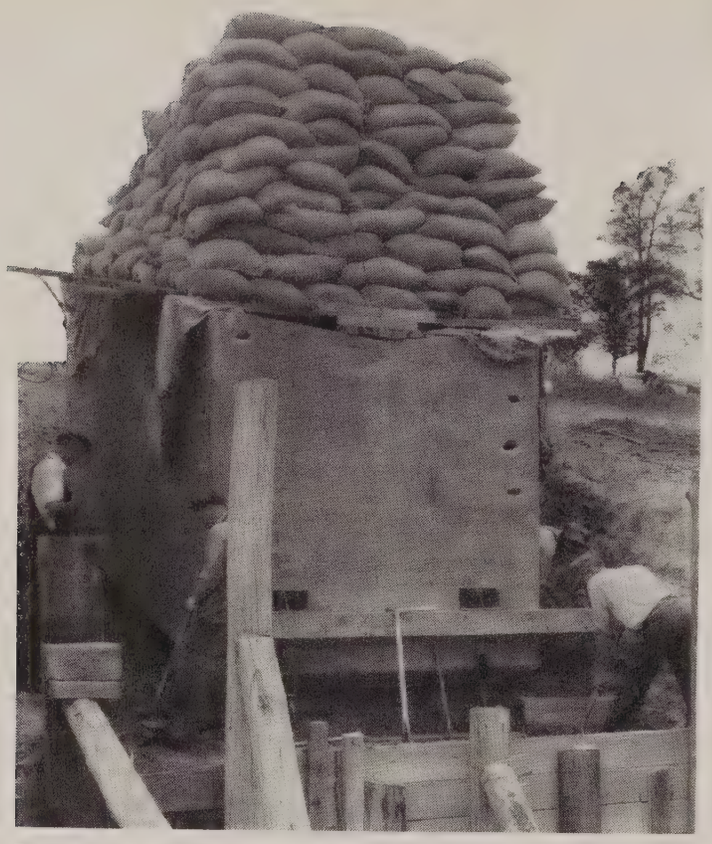


A CONSTRUCTION program, somewhat mystifying to a few of the old residents, has been going forward during the past year and a half near Coshocton, Ohio. A number of batteries of lysimeters are being built upon the North Appalachian experimental watershed, a project of the section of the watershed and hydrologic studies of the Research Division of the Soil Conservation Service.

A lysimeter may be defined as a structure containing a mass of soils designed to permit the measurement of the amount of water percolating through the soil mass. Three distinct types of lysimeters have been used—the transported, the in-place, and the so-called Russian type. In the transported type, the lysimeter unit is constructed and then filled with soil. The in-place type of lysimeter is built in such a way as to contain an undisturbed soil mass, with its horizons intact. The Russian type of lysimeter consists of a shallow pan inserted at desired depths under undisturbed soil horizons.

The installation, over 150 years ago, of the first lysimeters is commonly credited to the English scientist, Dalton (recognized as the father of the atomic theory), in his effort to determine the amount of precipitation which percolates through the soil. The Coshocton lysimeters have been designed primarily for water cycle studies, and are of the in-place type.

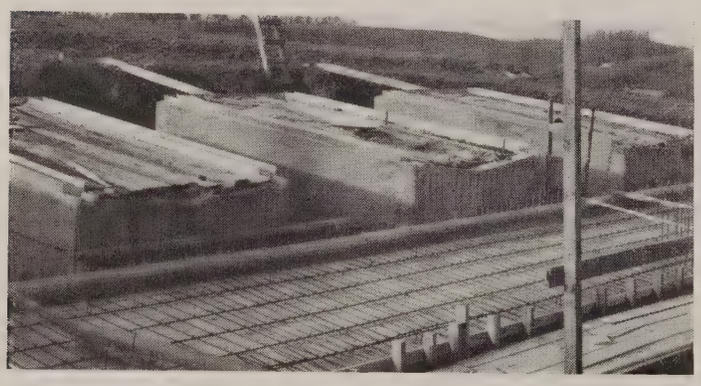
[1] In Charge, Soil and Land Use Unit, Watershed and Hydrologic Section, Research Division, Soil Conservation Service, Washington, D. C.



Lysimeter box shown sunk about half-way down; over 10 tons of sand were necessary to overcome friction between soil mass and asphalt-treated box sidewalls.

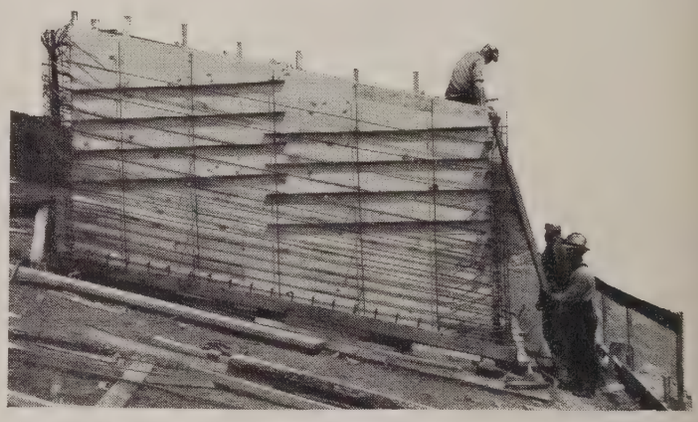
The lysimeters are built in groups of three. The horizontal projectional dimensions of each unit are 6.22 feet by 14 feet; the depth is 8 feet. The projectional surface of each unit is 2 milacres. The lysimeters have been designed and built to study the amount and rate relationships between rainfall, run-off and percolation, and to evaluate the magnitude of evapo-transpirational water loss.

A schematic diagram depicting the principal features of the lysimeter is shown with this article. In order to study the relationship between amounts, intensities, and duration of intensities of rainfall, run-off and percolation, the lysimeters are built to contain an undisturbed block of soil comprising the complete soil profile and including about 2 feet of the parent rock material. They are provided with catchment tanks to collect the rainfall, run-off, and percolation waters. The catchment tanks are equipped with mechanisms which allow central recording upon a clock-driven chart of the amount and intensities of the water piped to them. An automatically recording weighing device has been developed expressly for use in this study. This device is capable of recording automatically, at stated intervals, the time of the weighing and the total weight of the 130,000-pound lysimeter and soil mass within 5 pounds. This is less than one one-hundredth of an inch of precipitation over the area of the lysimeter. The record of the weight of the lysimeter at definite times will serve as a check upon the observed precipitation, run-off, and percolation data. It will give data upon evapo-transpirational water loss adaptable to interpretation in terms of surface area.



Three lysimeter units have been sunk into place. An early stage in the construction of the collector tunnel is shown in the foreground.

This lysimeter installation, based upon a detailed study of preceding lysimeter installations, is the result of much thought and effort on the part of over 15 individuals, comprising members of the Soil Conservation Service, the Ohio Agricultural Experiment Station, and specialists in delicate large-capacity weighing devices. Actual construction was made possible for the most part through the active cooperation of the Works Progress Administration. A number of technical papers dealing with the design and construction procedure of these in-place lysimeters are now being prepared.



An early stage in the construction of an in-place watercycle lysimeter. Reinforcing steel is being placed in forms in preparation for casting of the concrete box.

More than 40 percent of the soil wealth is contained in the top 6 inches of soil.

The Romans noted the folly of growing the same crops on the same land for several consecutive years.

PROTECTING BOTTOMLANDS FROM EROSIONAL DEBRIS: A CASE HISTORY

By Carl B. Brown [1]

IN many parts of the United States cultivation of fertile bottomlands and gentle alluvial slopes is being menaced by erosional debris swept down in storm run-off from adjacent denuded mountains and steeply sloping uplands. The damage resulting when debris-laden torrents gush out upon flood plains, with sudden dissipation of velocity and deposition of debris load, is usually twofold: (1) The natural and artificial drainageways on the alluvial slopes and bottomlands are clogged with debris, and subsequent flooding of fields by storm run-off occurs; ground-water levels rise, and land becomes waterlogged. (2) Assorted and usually coarser erosional debris derived from subsoils and spread over the bottomland impairs its fertility and often destroys its productive value.

Damage of this type is usually local, restricted at first to the immediate debouchure of tributaries on a flood plain or alluvial slope, but spreading progressively as the process continues. It should be distinguished from similar widespread sanding and aggradation produced during floods by alluvial streams on their own flood plains with sediment often transported from far distant headwater areas. For the latter phenomenon, no immediately effective cure is yet in sight; extensive soil conservation, changes in land use, and direct flood-plain protection will be required. Protection against local damage from erosional debris is, however, frequently obtainable in a short span of time and may be economically justified. It is, indeed, often a problem of immediate concern because alluvial lands are nearly everywhere notably productive and are rarely subject to the hazards of soil erosion common to most upland areas. Developing optimum methods for this protection is proper work for the Soil Conservation Service.

Elaborate and costly means are sometimes justified on thickly-populated alluvial lands. Debris basins formed by concrete dams have been constructed by the Los Angeles County Flood Control District on the alluvial slopes at the base of the San Gabriel Mountains for protection of suburbs of Los Angeles. But for the protection of ordinary agricultural lands, other and more economical methods must be sought. The first hope, of course, is adequately to protect by soil-conservation measures the watersheds from whence the erosional debris comes. This at once brings forth pertinent economic questions involving costs justified for the protection of both upland and alluvial soils.

THIS article describes one solution of this problem, and lays a partial basis for appraising its merits. It is based on a survey made by the Section of Sedimentation Studies, Division of Research, in June 1937.[2]

Doniphan County, Kans., the State's extreme northeastern county, is bordered on its north and east sides by the Missouri River. Intermittent areas of flood plain along the river are intensively farmed because of their fertile alluvial soils.

One of these areas, comprising 4,300 acres, is in Burr Oak Township, approximately 8 miles northeast of Wathena. The area consists for the most part of river-deposited alluvial soils fringed along the river by sand bars and debris, mapped as River Wash. On the south side the area is bordered by a steep and relatively straight bluff line through which a number of small tributary streams have cut steep and narrow ravines leading from the rolling uplands.

All the soils of this alluvial area are members of the Sarpy series,[3] of which Sarpy clay is most common, with lesser amounts of Sarpy silty clay loam and Sarpy very fine sand loam. The Sarpy silt loam which occurs principally along the bluff line represents an admixture of silt and coarser material from the uplands with clay of the river alluvium.

OF the several tributaries heading in the uplands and flowing onto the alluvial flood plain, Chase Creek is the largest. It has a watershed of 1,011 acres. Old residents report that 40 years ago both this small watershed and the bottomlands were well forested, and that water emerging on the flood plain was usually clear or that its occasional small-silt load was deposited in thin layers over the wooded bottom. Between the time of clearing the watershed and 1920, Chase Creek had built an alluvial fan sloping in all directions from its mouth for an average distance of 1,500 feet. The apex of the fan was 6 feet higher than the outer fringe giving a slope of approximately 22 feet to the mile. Much of the material composing this fan is said to

[1] Associate Geologist, Section of Sedimentation Studies, Division of Research, Soil Conservation Service, Washington, D. C.

[2] Acknowledgment is due to E. M. Flaxman, junior geologist, who, assisted by E. H. Moser, Jr., made a topographic survey of these debris basins and collected additional information on their history.

[3] Knobel, E. W., Davis, R. H., and Higbee, H. W. Soil Survey of Doniphan County, Kans., U. S. Dept. Agr. Bur. Chem. and Soils Series 1927, No. 25.

17389—37——2

have been brought down as the result of a cloudburst in June 1917.

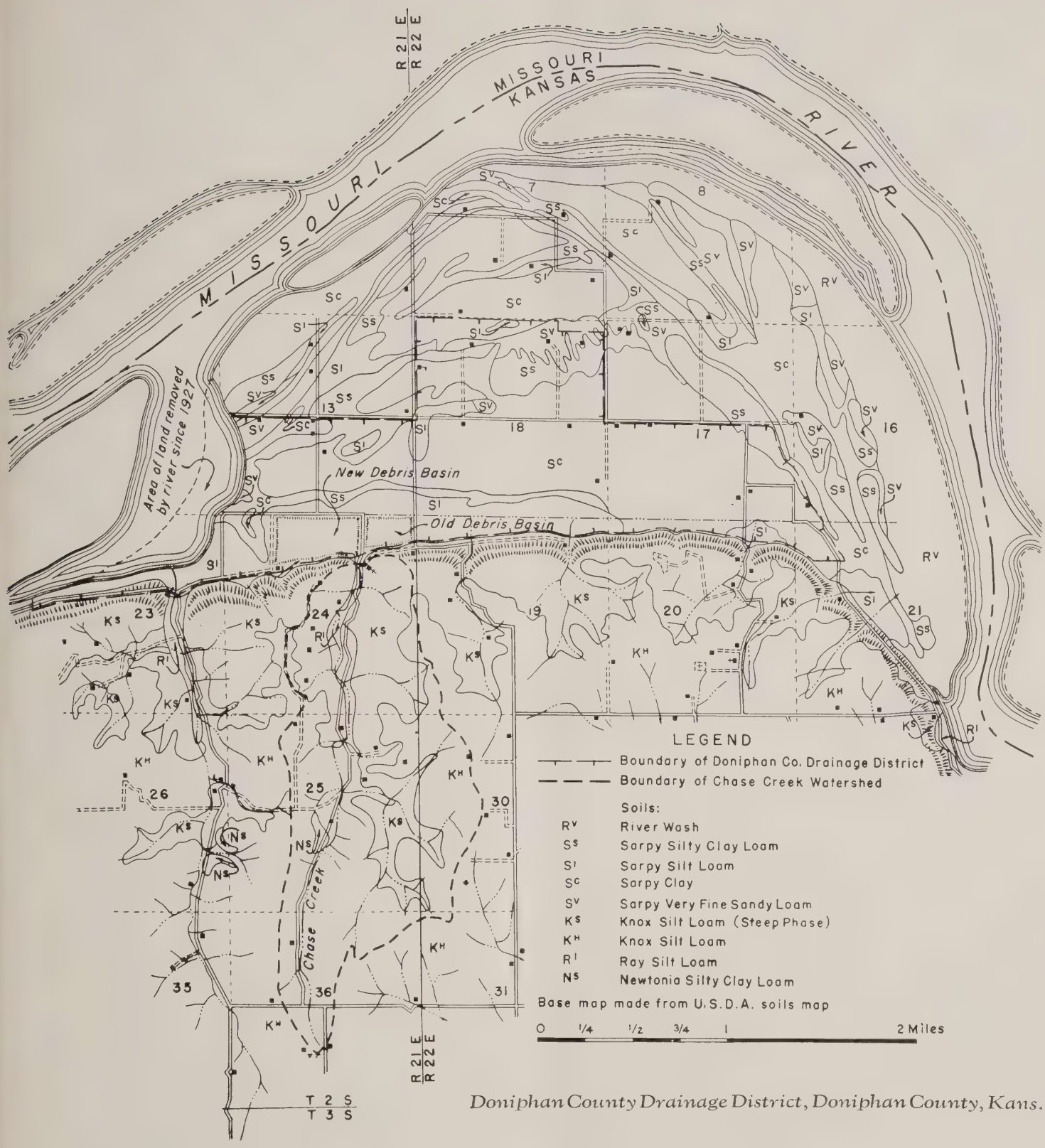
The damage resulting from the storm of June 1917 through flooding of growing crops and spreading erosional debris over them, led farmers in the afflicted portion of the flood plain to organize the Doniphan County Drainage District in 1919, taking in 1,900 acres of bottomland. An engineer was employed to survey the area and make recommendations for control of floodwaters and erosional debris and maintenance of drainage. He recommended the construction of a debris basin or diked-off area adjacent to the bluff line to impound both sediment and floodwater until the latter could drain off quietly into a ditch and be carried directly east 2½ miles to natural sloughs draining into the river.

IN 1920 a contract was entered into between the district and C. F. King for rental of 26.6 acres of his land lying just east of the mouth of Chase Creek (sec. 24, R. 21 E., T. 2 S.). This is indicated as the "old debris basin" in the accompanying map. This land was converted into a basin by an earth dike averaging 6 feet in height. The dike on the north side constituted the inner side of the drainage ditch and a second parallel dike constituted the other side. The ditch was dug about 3 feet below ground surface, the excavated material being used in the construction of the dikes. The ditch, which was 10 feet wide, thus had an effective depth of 9 feet. Beyond the desilting basin, no dikes other than spoil banks were constructed along the ditch. The ditch slopes 4.21 feet per mile to the slough where it terminates. No outlet from the basin was provided and water generally escaped by percolation and evaporation, except occasionally when it overflowed the dikes. Whatever damage occurred from overflow was periodically repaired. The flow of Chase Creek was diverted into the basin by a road embankment built across its original channel.

BY 1930 the original basin had completely filled with sediment and the channel was diverted into a similar basin of 73 acres on the west side of the mouth of Chase Creek. Between the spring of 1920 and the spring of 1930, the original basin was filled to an average depth of 5 feet with sediment derived from the 1,011-acre watershed. The depth varied from 8.2 feet near the entrance of the creek to 2.8 feet in the northeast corner. Within this decade, the sediment deposited amounts up to 135.6 acre-feet, equivalent to a removal of 0.13 foot of topsoil over the entire watershed. To this must be added an unknown quantity of sediment that was carried down the drainage ditch, particularly after the basin was nearly full. The ditch was cleared out for most of its length in 1930, a fact which shows that even the spill-over sediment was too coarse or too abundant to be carried by the waterflow on a grade of more than 4 feet to the mile. The indicated rate of erosion, based on sedimentation in the basin alone, would cause complete removal of the 6-inch topsoil layer (average depth for Knox silt loam) in 35 years or less.

THE contract between the district and Mr. King provided for rental of 26 acres of land at the rate of $25 per acre per year, but allowed him to continue such use of the land as he might choose, subject to flood hazard. Mr. King planted the land almost every year and crop production was extraordinarily high when no floods occurred. His production of corn ran 65 to 80 bushels to the acre when no damage occurred, a record that has been maintained since waterflow was diverted to the new basin. He reports that one year he raised 103 bushels to the acre. These figures compare with an average production of about 40 bushels per acre on adjacent alluvial land. They indicate in a most striking way the plant food values lost from the Chase Creek watershed and laid down on this field. Taking into account crop losses by flooding, Mr. King averaged 25 bushels of corn per acre in the debris basin during the 10-year period. King also derives excellent yields from tomatoes, watermelons, strawberries, and beans on the old silting basin. The more sandy soils in the upper part of the basin are used principally for truck crops and the finer-textured soils in the lower part for corn. There have been no appreciable differences in crop yields over a period of years.

THE new desilting area is not surrounded by a well-defined dike. Instead the water is directed along the edge of the bluff by a low dike about 200 feet in front of it. This abruptly checks the incoming current and causes deposition of coarser materials, temporarily protecting the remainder of the basin. A road to the west, north, and east of this basin is 2 to 3 feet higher than the enclosed land, and the drain on the inside connects with the old drainage ditch and serves as an outlet for surplus water.



Doniphan County Drainage District, Doniphan County, Kans.

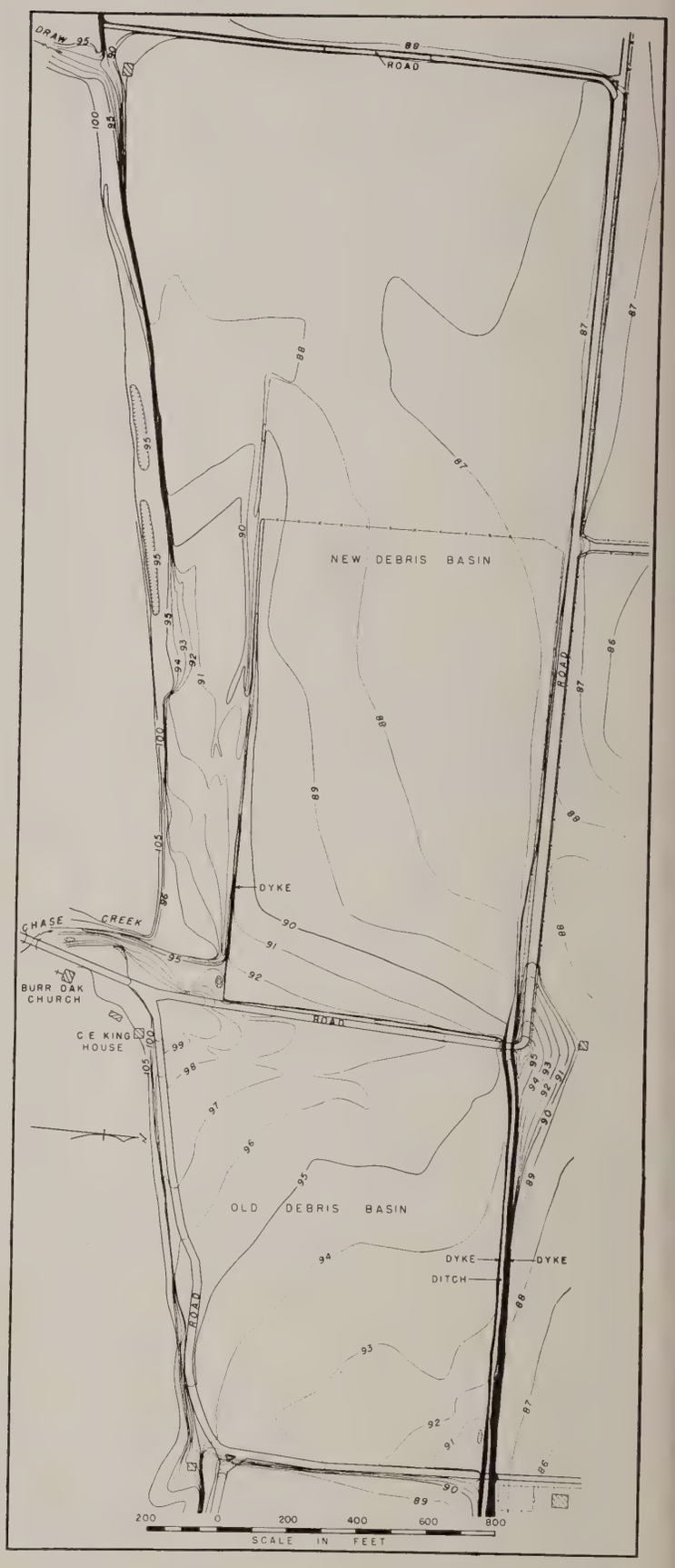
On June 7, 1937, a cloudburst caused a flood which tore out a portion of the low dike where it is buffeted by the direct current from the mouth of the creek. Boulders derived from bed rock were strewn over 1 to 2 acres below the mouth of the creek, and a deposit of medium to coarse sand extended beyond. Most of the sediment, however, was deposited on the western half of the basin. The silt deposits were thick enough to make necessary replanting of the corn crop.

The watershed of Chase Creek is entirely covered by Knox silt loam and its steep phase. More than 90 percent is in cultivation and orchards, woodlands being restricted to the narrow valley of the creek and the steep slopes along the Missouri River bottomlands. The principal crops are raspberries, beans, and other garden truck, with corn, wheat, and rye on the flatter uplands. Apples are the principal orchard crop.

On the basis of information supplied by King, it is computed that the district has paid a rental of $12,835 for the debris basins from 1920 to 1937. If we exclude all other costs of the district such as the small annual maintenance and interest on the $30,000 of 30-year bonds issued to finance the improvements we find that the average rental cost for debris basins alone has been about 35 cents per acre per year for land protected. That this amount as an insurance against crop loss was fully justified can scarcely be doubted. According to King, it is anticipated that after the bonds have been paid off the annual drainage district special tax will not exceed $1 per acre. It appears from the facts at hand, without the benefits of an economic survey, that the drainage district has been a success with respect to costs versus benefits.

Looking at the other side of the picture, however, the total rental payments to date for the debris basins are equivalent to $12.70 per acre of watershed area. This compares with a cost of $8.51 per acre treated with soil conservation measures on the Muskogee, Okla., demonstration project, or an average cost of $6.09 per acre, for the gross acreage of the 37,000-acre watershed. It is higher than the total costs per acre on seven of the nine demonstration projects put on a maintenance basis at the end of the fiscal year 1937. Therefore, it appears that with the same or a smaller expenditure during the 17-year period for treating the Chase Creek watershed not only would the same protection have been afforded for the bottomlands but at least 415,000 tons of valuable soil (24.5 tons loss per acre per year) would still be in place instead of the debris basins. Soil conservation appears in this case as probably the most favorable alternative even if the debris basins had been constructed as insurance for the initial period of 2 or 3 years until proper land treatment was successfully concluded.

It is believed that two significant points are brought out by this study: (1) Treatment of a watershed of sloping upland solely to protect valley agricultural land to which it is tributary can often be justified from an economic standpoint. (2) Debris basins alone frequently offer a successful method of protecting valley agricultural lands, and adaptions of this practice may prove useful in operation work, under some circumstances, as a relatively cheap and expedient method of protecting bottomlands until soil-conservation treatment of tributary watersheds can be completed; or in very rare cases, use of debris basins may be the only or ultimately the cheapest method to employ.



Topographic map of debris basins, Doniphan County Drainage District, Doniphan County, Kans.

THE BERMUDA GRASS KING *by* Angus McDonald[1]

THEY will tell you in Fort Smith that Harry E. Kelly is the Bermuda Grass King of Arkansas. He is called the "Bermuda Grass King" because he has over 2,000 acres of Bermuda grass and because he has had it set all over Arkansas and the South and Southwest. His work with Bermuda grass has carried him to Australia and all over the United States.

The land south of Fort Smith is the poorest I ever saw. It is a mass of shale with a few inches of soil over it. In some places there is nothing but bare rocks. Some of the hilltops were once entirely bare—"bald knobs" they were called. It was a God-forsaken country; the soil was thin and washy and great gullies marred the hillsides. In 1887 Harry Kelly moved to the south of Fort Smith. Shortly after he became interested in Bermuda grass.

"I knew that a country could not be prosperous without good pastures," he told me. "When I came to this country in 1887 this field here had been farmed in cotton for 80 years. It was so run down that it wouldn't grow anything. The hillside was a maze of gullies, some of them as deep your head."

"Where are the gullies now?" I asked. I looked up the long slope that was covered with Bermuda grass from 6 to 8 inches high.

"Come on up to the top of the hill. I want to show you something," said Mr. Kelly.

I drove up the slope. When we got to the top I saw Bermuda grass growing on what was almost a solid mass of rocks. Some of the big, flat sand rocks were a yard across but they were nearly covered with the long Bermuda runners.

"Bermuda grass will grow where nothing else will," said Mr. Kelly. "It will stop erosion when nothing else will. There is more money in it than in corn and cotton and it builds up the land. Thirty years ago I carried a shoe box full of the roots to a farm I own in Ozark County, Missouri. From that shoe box I have set 300 acres. It will take this country. It will save the farmers in spite of themselves. It will choke out the cotton, overrun the fields. I had it set all along the roads and highways." He laughed uproariously. "It spread into the fields. It took the land. You see this 50 acre field? Twenty-five years ago it was a cotton field. But the Bermuda spread from the road. It took the field." Again he laughed, laughed so long and loud that I joined with him.

"These farmers' wives fuss at me. They are afraid their men will get the Bermuda grass fever. They don't like it because it spreads from the roads into their gardens and flowers."

"What about row crops? You've got to have row crops", I said. Mr. Kelly's jovial face changed. He scowled at me. "Row crops!" he shouted. "You don't need row crops with Bermuda. Row crops have caused this country to wash away.

"Other methods", snorted Mr. Kelly. "Yes, there are other methods, and compared to Bermuda none of them is worth a good cuss word. Bermuda is the only real soil saver."

"Have you tried other methods?" I asked.

"All I ever heard of—and quit them because Bermuda was better. You see that post there? I set that post 15 years ago 7 feet out of the ground. It is 3 feet high now. The sod has filled up 4 feet of soil. You see that ditch?" He pointed to a drain ditch alongside the road. "That ditch was over a horse's back 10 years ago. It was eating out into the road and into the field on the other side. I set it in Bermuda. Look at it now. Look at it now!" he said triumphantly.

I looked. The ditch was about 18 inches deep. Its walls and banks were matted with Bermuda and long fingers of grass were reaching toward each other from either side in its bottom.

"We have to plow that ditch every year or two to keep it from clogging up. And you talk to me about other methods!"

We drove by pasture after pasture of Bermuda grass where fat cattle grazed. We drove over hill and dale, over rocky land, thin land, good land, bad land, and the Bermuda was thriving everywhere.

"I have lots of trouble getting these farmers to take care of the pastures. You see this farm here?" said Mr. Kelly. "Fifteen years ago I had it rented. It had been set in Bermuda grass in 1904 and needed plowing badly. But the fellow wouldn't plow it. 'No', he said, 'I'm not going to ruin that Bermuda by plowing it up.' Well, he owed me $4,000 and I had renewed the note twice, and I said, 'Well, if you don't plow that pasture up I won't renew your note.' The fellow went around to the other banks and tried to get some money, but failed, and so he came back and said, 'All right, you win.' He plowed up the Bermuda and it helped it a lot, but it needs plowing again."

[1] Formerly Assistant Soil Conservationist (Erosion History), Section of Climatic and Physiographic Research, Soil Conservation Service, Washington, D. C.

"Have you developed any superior varieties of Bermuda?" I asked.

"Well, I've experimented a great deal. I've tried a great many varieties, but the kind that has been growing here the longest is the best and hardiest. It has become acclimated. There is a plat of Bermuda near the old fort that is 104 years old. I talked to an old soldier in the early days who saw it set out in 1833. It is still doing fine. I have brought many other varieties here from many parts of the world. I've got varieties from Arizona and Australia, but it froze out. Bermuda's worst enemies are cold and shade. It will grow in rather open timber, though. Look at that." I stopped the car. Not far off there was a good stand of Bermuda growing among some red oak trees.

"Well, I should say there's another enemy and that is dog fennel. These farmers won't pasture their Bermuda enough and the dog fennel comes. To do well Bermuda ought to be pastured a good deal. There's not enough cattle in this country. Bermuda will support from three to five head of cattle to the acre. Show me another grass that will do that. Yet some of these farmers are afraid of it.

"But let me tell you about the time I went to Australia. Did you know that New Zealand was one of the richest countries in the world? Did you know that New Zealand exported more butter than any country in the world and that it is all on account of Bermuda? I was going over on the boat in 1904 to Australia and I got to talking with an Englishman who said he had a little ranch of 7,000 acres he had just sold for $200 an acre. He said they raised Cooch grass on it for pasture. Said it was the finest grass in the world. When we got across he took me out and showed me some of this Cooch grass. What do you think it was? As fine Bermuda as ever you saw! But that Australian Bermuda isn't as good for this country as what grows here.

"Bermuda Grass Mitchell has developed some fine varieties. But none of them is any better than this grass around Fort Smith. Mitchell has done a lot, though. He got the Bermuda grass fever along with me and John Fields in the early days. We made speeches all over this country. And every time we wrote an article we harped on Bermuda. John Fields and I made a Bermuda compact in 1902. He was editor of the Oklahoma Farm Journal. He agreed never to publish an issue of the paper without an article on Bermuda. And he carried out the agreement as long as he was editor. But we lost him," Mr. Kelly said, sadly, "He went in with the farm-loan people. That was a good many years before he died."

"I guess you have sold a lot of the Bermuda roots", I said.

"Sell it! I should say not. I've never sold a single sprig. But I've given it away. I've given away thousands and thousands of sacks of the sod. They come here and dig it up free of charge.

"One of the chief obstacles to spreading the Bermuda grass light", went on Mr. Kelly, "has been prejudice. The foremost farmer in this country today has been saved by Bermuda grass almost against his will. That's Claude Hampton. Claude Hampton worked for me for 9 years and I never could convert him to the Bermuda grass doctrine. Annie, his wife, said his mother hated the grass and I reckon Claude had a prenatal antipathy to it. Annie said if you showed Claude a sprig of Bermuda he would spit at it like a kitten does at a dog. Claude had a fine bottom farm, over 200 acres, and he wouldn't allow Bermuda on it. Well, in 1927 the great flood came and covered all his land with a layer of white sand from 6 inches to a foot deep.

"Claude came to me and said, 'Well, Mr. Kelly, I'm ruined. The water has ruined my land.'

"I said, 'Claude, why don't you set it in Bermuda?' But Claude just laughed. He had heard me harp on Bermuda so much.

"Well, the next thing I knew Claude had got some Bermuda seed from Arizona. You ever been in Yuma, Arizona? Did you know there was a seed mill there that has developed machinery that will separate alfalfa seed from Bermuda seed? Well, anyway, Claude sowed his land in Bermuda in May and got a fine stand.

"The best way to start Bermuda though is from the roots. I use a manure spreader to scatter it and then turn it under with a turning plow."

While Mr. Kelly was talking we had been approaching the edge of the Arkansas River bottom. In front of us was a comfortable-looking farm house surrounded by a Bermuda grass lawn. The house was situated on a rise just above the bottom.

"Look at that Bermuda grass pavement," said Mr. Kelly. The Bermuda grass had almost covered the road in front of the house. "This is where Claude Hampton lives."

We got out and I met Hampton and he drove us down into the bottom. Before us stretched 200 acres of the finest Bermuda grass I ever saw. Most of it stood 12 inches high.

"How long will Bermuda live under water?" I asked Mr. Kelly.

"Well, I don't know. Never have known water to stand on it over 4 or 5 months. It always came out."

"In this pasture is about 100 acres," said Mr. Hampton. "I've got 125 head of cattle on the grass. You can see they haven't eaten a tenth of it, and they are fat as butter."

We stopped near a grove of trees where a bunch of cattle were shading. They were as fat cattle as ever I saw.

"I don't feed 'em a thing the year around. They live on Bermuda through the winter," said Mr. Hampton.

"Did I tell you about the time I converted the packing house people to Bermuda?" asked Mr. Kelly. "Well, the packing house man traveled around the country looking for a place to locate. I had been talking pasture and cattle to him but he said this wouldn't make a cattle country. 'Your grass ideas are all right', he said, 'but it would take too long.' 'Now you look here', I said, 'I want to show you something.' I took him down to this bottom about 9 o'clock one morning and it was 10 o'clock before he was ready to leave. He was converted all right, and that's how Fort Smith happened to get the packing house."

"I guess they might call you one of Mr. Kelly's disciples," I said to Mr. Hampton.

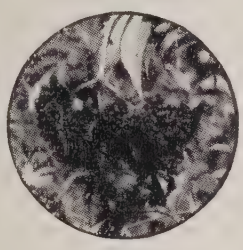
"I guess they might", said Mr. Hampton. "Mr. Kelly kept telling me to quit work. I just sit in the shade and watch the cattle get fat."

The second bottom near Hampton's house was set in Bermuda too—but part of it had grown up in weeds.

"Claude, how about plowing this up?" said Mr. Kelly. "It would help the Bermuda."

"Well, you know you told me to quit work and I'm trying to follow your advice," said Claude.

Driving back to the house Mr. Kelly said, "I have spent 50 years carrying the Bermuda gospel. When I was a young man I decided to devote my life to Bermuda. And I have. Or most of it. I am 76 now."



Sambucus canadensis, *the common elder.*

A Border for the Woods

By William R. Van Dersal [1]

IF plantings are to conserve soil on the poorest, steepest land, some provision must be made to ensure health and vigor to trees as they grow older. This involves precautions about woodland edges. Edging the woods with a border of shrubs is one way to give protection.

Anyone who has seen virgin timber after a portion of the tract has been logged-off knows what damage wind can do to trees.[2] A shrub border protects the woodland from drying winds by forcing them up and over the trees, thus preventing the air currents from sweeping through the woodland to blow away litter, dry the humus layer, and prevent satisfactory reproduction. Planting a proper shrub border is tantamount, in a sense, to streamlining a tree plantation. In the Plains area, successful establishment of tree windbreaks depends upon low-growing, protective plantings on both sides.[3 4 5] Examination of undisturbed natural woodlands always shows a bushy border—as any picnicker who has ever tried to get into the woods from the road can attest.

Shrub borders also cause better development of the edge trees, inasmuch as the crowding of shrubs against the trees results in natural pruning. Trees at the edge of a plantation always develop sturdy limbs on the outer side, and these make poor timber. But when tall shrubs shade the trees, only slender limbs develop—and these are later lost.

A PROPERLY planned shrub border attracts to the woodland various species of birds. It is well known that woodlands without diversification, especially if composed of one species, harbor a relatively small feathered population.[6] It is also painfully evident at times that insect damage and insect-borne disease becomes a serious matter in many woodlands. European foresters have attempted to attract insect-

---

[1] Biologist, Section of Wildlife Management, Soil Conservation Service, Washington, D. C.

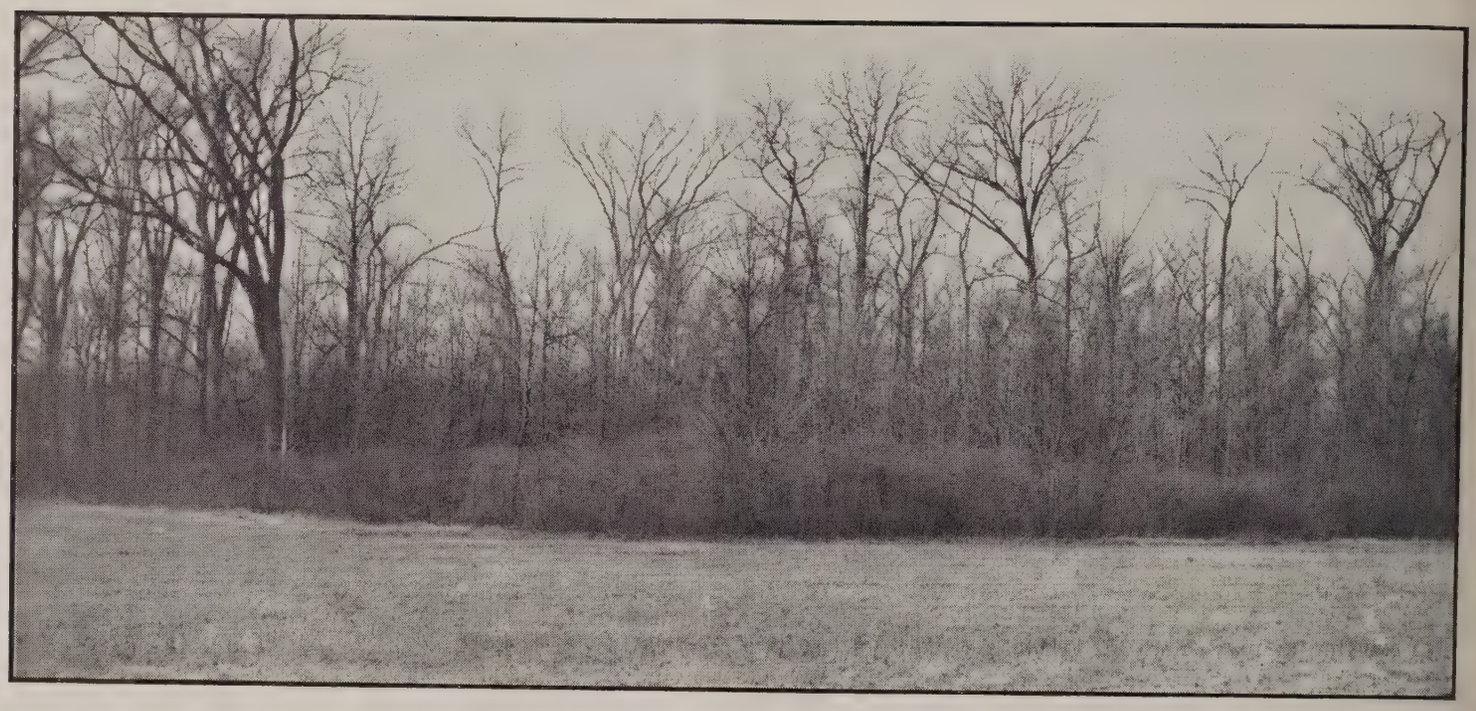
[2] Troup, R. S. 1928. Silvicultural Systems, 199 pp., illus. Oxford. See particularly pp. 8, 68, 93.

[3] Olson, D. S., and Stoeckeler, J. H., 1935. Possibilities of Shelterbelt Planting in the Plains Region. Sec. 4—The Proposed Tree Plantations—Their Establishment and Management, pp. 15–27.

[4] George, E. J., 1936. Growth and Survival of Deciduous Trees in Shelterbelt Experiments at Mandan, N. Dak., 1915–34. U. S. Dept. Agr. Tech. Bull. 496, 48 pp., illus., p, 43.

[5] Sholz, H. F., 1935. Causes of Decadence in the Old Groves of North Dakota, U. S. Dept. Agr. Circ. 344, 37 pp., illus. (See p. 32.)

[6] Forbush, E. H., 1908. Useful Birds and Their Protection. 437 pp., illus., Mass. State Bd. Agric., Mass. See especially pp. 90–110.



A natural border of shrubs on the edge of a woodland in Vermont.

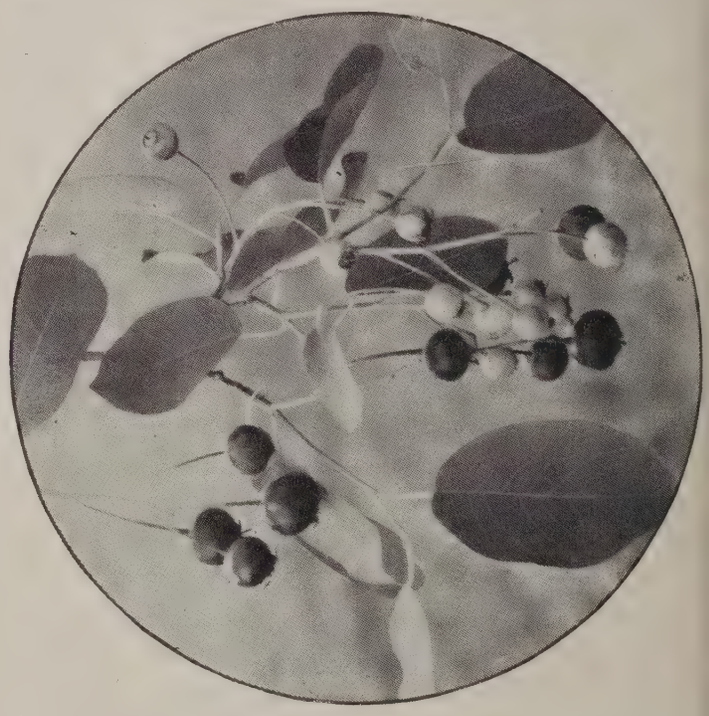
Mulberries are widely known for their attractiveness to birds. They grow well on woodland edges.

eating birds into nondiversified woodlands by placing birdhouses in their plantings. Shrub borders, however, coupled with uneven-aged stands and occasional openings, are more effective in holding large numbers of birds near woodland areas. The fruiting shrubs, it may be added, provide food for fur bearers, many of which include a considerable percentage of insects in their diets.

Plants valuable for borders fall into four classes: Small trees, tall shrubs, low shrubs, and vines.

The small trees of value in such plantings include juniper, flowering dogwood, osage orange, hawthorn, persimmon, mulberry, mountain ash, wild black cherry, pin cherry, boxelder, and hophornbeam. All these have value for birds. Incidentally, junipers and hawthorns are never planted together because the cedar-apple rust depends upon these two, among others, for its development.

THE tall shrubs that may be planted outside the small trees include viburnums, sassafras, wild plums, shrubby oaks, sumacs, service-berries, hazelnut, honeysuckle, elderberry, prickly ash, shrubby dog-



Amelanchier canadensis, *serviceberry. These fruits, ordinarily produced in the open but less commonly inside the woodland, are of importance in many bird diets. This and other serviceberries readily find a place in border planting.*

woods, hollies, shrubby hackberries, and crabapples. In the West, manzanitas (*Arctostaphylos* spp.) and ceanothus may be used in addition. Russian olive, caragana, and lilac are shrubs of considerable importance in windbreak planting, although the latter two furnish little food for wildlife. Species that appeal particularly to birds should be—and are—selected.

The low shrubs planted outside the tall ones may include wild blackberries, callicarpa, snowberries, coralberry, dwarf papaws, chokeberries, wild roses, and even low-growing wild cherries, all of which produce food sought by birds.

Cornus paniculata, *one of the shrub dogwoods useful in woodland borders and of value to wildlife.*

Vines are advantageous along woodland edges. It makes little difference how vines clamber over the border plants. In fact, the more luxuriantly they develop, the better protection the border offers to the trees inside. Vines planted inside the woodland may often be serious competitors of trees. When old vines are already present they can profitably be left to supply wildlife food, but in new plantings vines ought to be planted in the edges. Grapes of all kinds are acceptable to scores of birds as well as man himself. Virginia creeper, smilax, bittersweet, and other climbers may be expected to encourage bird life as well as to consolidate the border.

The practice of woodland border planting fosters two land uses—the production of wood products and the production of wildlife. Here, certainly, multiple land use and erosion control is achieved by a method that combines several practices into a harmonious whole.

Vibernum dentatum, *one of the viburnums adaptable to border planting and valuable for wildlife.*

Wild grapes figure prominently in scores of bird diets. They can be used to make the woodland-protecting border more dense.

FOR CONVENIENCE IN SUBSCRIBING TO SOIL CONSERVATION

Superintendent of Documents, Government Printing Office, Washington, D. C.
Enclosed find $1 (foreign, $1.40), for which please enter my subscription to SOIL CONSERVATION for one year.

.....
Name (*Write plainly*) Address

FOREST DESTRUCTION AND SOIL EROSION IN MADAGASCAR

By Charles F. Swingle [1]

Because of an old legend, Madagascar has been referred to as "The Land of the Man-Eating Tree." Due to the ruthless way in which the natives have destroyed their once magnificent forest, however, the appellation might well be "The Land of the Tree- Hating Man." As in most countries, the development of agriculture in Madagascar has necessitated some clearing of forests. One can understand, even if not condone, the careless disregard of the native, living in the midst of vast forested areas, for a few trees. With a limitless reserve of wood at hand, why take thought of the future in clearing for the all-important rice culture?

THROUGHOUT the centuries, as the forests disappeared gradually and were replaced by highly inflammable grasses, the burning of vast areas by hand-set fires became common practice. At the present time the only limit to the fire is the lack of anything to burn. And, strangest of all, with the almost complete destruction of the forest and the consequent dependence upon a timber supply at considerable distance, there appears to be no change as regards the Malagasy's odium for trees.

The Rain-Forest

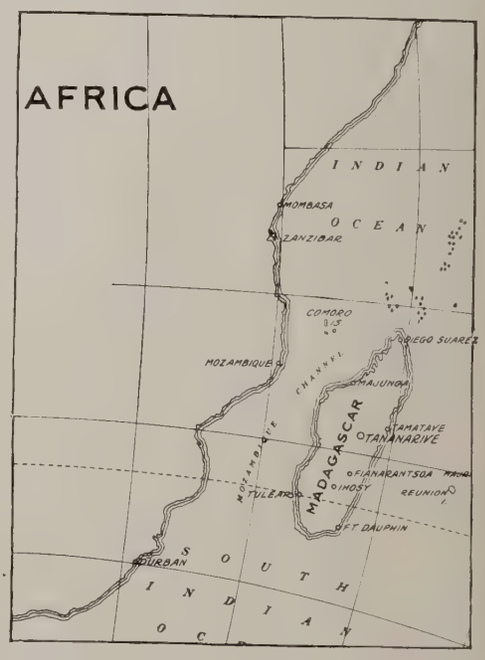
Originally, almost the entire area of France's "Great African Island" was covered by a dense forest. Today almost nothing remains of it except a strip of mountainous rain-forest 50 miles wide lying along the east coast, bordering the Indian Ocean. Here, even though there has been considerable exploitation of valuable tropical timbers, soil erosion is negligible, for with the almost continuous rain-fall, when the cover is removed it quickly replaces itself.

Central Plateau Conditions

On the other hand, the broad central plateau, some 200 miles wide and extending almost the entire thousand-mile length of the island, is characterized by more of a continental climate, with definite seasons of rainfall and comparative drought. In this region, holding the greater part of Madagascar's 4 million inhabitants, rice culture is of paramount importance, with everything else secondary. Where original forest remains it is cleared by burning, with the natives giving no concern to the spread of fire beyond the confines of the planned rice field. Then, after but 1 or 2 years of high yields, the field is abandoned and the process repeated as long as any forested land remains. Unlike the condition on the east coast, however, because of the well-defined dry season and the soil characteristics the abandoned area does not come back to forest but yields instead only a scanty covering of inflammable grasses. Thus the hand of man combines with the burning tropical sun in transforming what was previously a fertile forest soil into a sterile, erosive, red, brick-like laterite. Hence another designation commonly given to Madagascar, "The Island of Red Rivers."

Region of Climatic Seasons

The western third of Madagascar, again extending almost its entire length, presents no sharp line of demarcation from the central region. The central high plateau slopes gradually toward the Mozambique Channel. The seasonal difference in climate becomes much more accentuated. Notwithstanding an annual rainfall of some 60 inches, the yearly cycle is so sharply divided between a wet and a dry season that the vegetation goes through much the same stages as in a more temperate country, with the leaves of many of the plants falling at the start of the dry season.



[1] Horticulturist, Section of Conservation Nurseries, Soil Conservation Service, Washington, D. C.

Formerly most of Madagascar was forested.

In traveling through the region of the west during the dry season, I have counted as many as seven distinct fires on the horizon at one time—probably each set by human hand. Here again the principal reason for fires is to make way for the rice field. In the west, however, rice culture gives way to livestock raising and doubtlessly many of the fires are set, as in our own country, with the mistaken idea that the best way to get a new grass cover is to burn off the old.

The continued burning reaches ever farther into the remaining stands of the original forest, so that these are limited more and more to rock-protected areas inaccessible to the fire. Once the fire reaches one of these forest remnants, it is gone forever. In neither the central nor the western part of Madagascar is the forest ever able to overcome the insurmountable obstacles of high temperatures, tropical insolation, heavy downpours alternating with long periods of drought, and a lateritic subsoil.

A very few species of trees, however, are able to make a feeble stand against the constantly recurring grass fires. As a result, these, along with a small number of grass species, make up the entire plant cover, meagerly replacing one of the richest floras of the world with an open savanna.

Rice-field terracing seems to reach its highest development in Madagascar.

The forest gives way to the rice "tavy."

The final stage of destruction on the plateaus is represented by a sparsely-grassed plain, with usually only two or three species of trees and with regularly spaced termite nests visible as far as the eye can see—certainly a desolate substitute for the magnificent forest which once occupied this land.

Erosion Follows Fires

Under such conditions the slopes are subject to devastating erosion, and the streams are choked with the soil carried down from above. And as an inevitable consequence, the characteristic picture of the country becomes the native with a jug, carrying water, and all too frequently from great distances.

The extreme southwest of Madagascar represents a continuation of the western part of the island in that it also has well-defined seasons. But here the rainy season is so short and uncertain as to actual rainfall, and the dry season so long and pronounced, that grass is able to make but little growth. Hence, because of its lack as the fire-propagating medium, the flora of the southwest is essentially the same today as it has been for centuries, and erosion is negligible, one of the few exceptions being the locally important but very limited sand dune erosion taking place along the shore of the Mozambique Channel at the mouth of the Linta River.

Devastation Nearing Completion

Looking at Madagascar as a whole, if we except the relatively small areas of the southwest where erosion is largely absent because of the lack of fire-propagating grasses, and of the east coast where it is too wet at all times for fire, we see that the magnificent tropical forest of the earth's fifth largest island has just about disappeared, due chiefly to hand-set fires. Many valuable species of plants are gone completely, and with the forest have gone the unique animals. And, as pointed out by the French observers, the disappearance of the forest accentuates the dryness of the air and soil, rapidly culminating in the washing away of all soil down to the rock.

Thus, rapidly are disappearing the natural riches of one of the most fertile areas of the world.

POST-WAR AGRICULTURE AND SOIL EROSION IN CZECHOSLOVAKIA

By Guy R. Stewart [1]

THE Republic of Czechoslovakia is made up of five districts which were largely in Austria-Hungary prior to the World War, with a small portion which was taken from German Silesia. The western portion of the republic consisting of Bohemia, Moravia, and Silesia, in most places ranges from hilly to mountainous with some broad and fairly fertile valleys. Prior to the war these districts produced a surplus of rye and barley for export. Slovakia, lying farther south, forms a part of the great Hungarian plain and is composed chiefly of excellent agricultural land which normally produces a surplus of wheat. Farther to the east, Ruthenia lies in the foothills of the Carpathians and, although it has a relatively limited production of grain, there has always been a considerable return from livestock and forest products. In the western portion of the Republic there are approximately 5,200,000 people who make their living from manufacturing and general industry while only 3,400,000 are engaged in agriculture. The soils of this part of the country are not sufficiently rich nor is the climate uniformly

[1] Assistant to the Chief, Division of Research, Soil Conservation Service, Washington, D. C.

Gully treatment in the Rakovník area (middle Bohemia).

favorable for successful farming. Slovakia, on the other hand, ordinarily produces a surplus of foodstuffs. The Republic, as a whole, is usually classed as being largely self-supporting.

Land Reform

Following the World War there was an expropriation of the larger holdings of agricultural land similar to that of Rumania. Out of a total of approximately 35,000,000 acres consisting of tillable land, pastures, and forest, about 9,500,000 acres were expropriated for sale to peasant operators. With this change in land-ownership there is some tendency for a decrease in the acreage sown to wheat which is more than made up for by a gain in the area planted to legumes, vegetables, and forage plants. There likewise is an increase in the land devoted to pastures and meadows.

Strip Land Erosion

Certain striking erosion conditions in Rakovnik, Bohemia, and in the basin of the Borsavy River in the Carpathians are described by Valek.[2] In these areas the soils are composed of rather deep sedimentary deposits containing an appreciable amount of gravel. Erosion in both areas appears to have been caused by the cultivation of unduly steep cropland having a gradient of 10° to 40°, as well as by overgrazing on upland pastures. As a result, there has been excessive run-off following rainfall and much debris and gravel has been washed down into the lower valleys. In places, gullies have developed so rapidly that the smaller stream channels into which they feed are practically swamped with mud.

On the grassland, the condition appears to have been intensified by a loss of pasture fertility owing to long continued grazing without proper fertilization. These conditions have been treated by retirement of the steepest slopes to woodland and by regulated grazing in the upland pastures. It is now proposed to treat watersheds such as these in a more comprehensive fashion and Valek[3] has published a plan for systematic improvement of the watershed basins of the Kychova and the Zdechovka Rivers. Figures on precipitation and stream flow have been gathered for the period, 1928–34, and it is planned that this work be extended into the future with a concerted attempt to relate the run-off to the land-use practices.

Condition and treatment of gullies in Hučivé Děsné area (northern Moravia).

[2] Valek, Zd. Manuscript communication—Report on Soil Erosion in Czechoslovakia.

[3] Valek, Zd. Recherches et Resultats De L'Etude De L'Influence De La Vegetation Sur Le Debit Des Eaux De Precipitation Dans Les Bassins Des Torrents De La Kychova Et De La Zdechovka Pour Les Annees 1928 a 1934. Recuil De Travaux Des Instituts Des Recherches Agronomiques De La Republique Tchecoslovaque. Svazek 144. Vol.

Contour Furrows Constructed Without Loss of Sod

By Merle W. Bloom [1]

View of furrows and ridges plowed by the contour-furrowing machine on a pasture in northeastern Iowa, three months prior to date of photograph.

AN implement that will build furrows and ridges without destroying the sod has long been needed for the establishment of contour furrows on pasture slopes. Such a special contour-furrowing plow which does not turn the sod, has been developed in Iowa.

The original plow was designed and constructed in cooperation with E. V. Collins, research professor in agricultural engineering at Iowa State College, on the Soil Conservation Service demonstration area at Marion, Iowa. The plow has been used successfully on the project area at Marion and in the camp areas at Eldora, Maquoketa, and McGregor, Iowa.

This machine was built from a standard 18-inch single-bottom plow. The moldboard was replaced by three spring-steel sod lifters which are attached so that they will not turn the sod over but will hold it at a

[1] Assistant agricultural engineer, Soil Conservation Service, Indian Creek watershed, Marion, Iowa.

Front view of contour-furrowing machine showing plowshare with three sod-lifters at left and sod-cutter blade with two sod-lifters at right, and soil-moving scraper-blade in background.

60° angle. An 18-inch sod-cutter knife was mounted on the left and 4 inches higher than the regular share edge. To the rear of this knife is welded two spring-steel sod lifters which raise the left-hand or uphill strip of sod.

A SCRAPER removes the underlying soil to a depth of 4 inches and pushes it under the right-hand strip. As the sod is allowed to drop in place, the downhill strip is held up by the soil that has been placed under it to form a ridge, and the uphill strip settles down where the soil has been removed to become the bottom of the furrow.

The ridge is held approximately 6 inches above the normal level, while the furrow sod settles to 3 inches below. Thus, an effective ridge is produced to extend 9 inches above the furrow bottom. Heavy concrete rollers behind the plow press the sod firmly in place thus securing good contact between the sod and the soil underneath. The roller also smoothes out the ridge and leaves it at a uniform height.

THE cost of constructing the original contour furrowing plow, including all materials and labor totaled $181.23, the approximate price of a two-bottom tractor plow.

It is estimated that contour furrows can be plowed on about 10 acres of pasture a day with this machine. Labor requirements consist of two men to survey for the furrows and a tractor operator to handle both the tractor and the plow. The contour-furrowing machine can be operated from the tractor as with any standard tractor plow. The power requirement varies for the Carrington, Tama, and Clinton soils of eastern Iowa, from a 2-plow tractor for the lighter soils to a 20-drawbar horsepower track-type tractor for the soils with more compact subsoil layers.

HERETOFORE the terracing equipment and turning plows used in building terraces and furrows on pasture destroyed from 5 to 20 percent of the sod cover. In contrast, the new contour-furrowing plow establishes uniform furrows without any loss of sod. This maintenance of the original sod does away with the necessity of reseeding and provides a protected furrow to hold the rainfall, resulting in increased savings of soil and moisture and subsequent increased pasture returns.

Work has been done on slopes ranging from 2 to 18 percent. Furrows are spaced from 10 to 20 feet apart, the spacing being designed in such a manner that the furrows will retain a total rainfall of 1½ or 2 inches regardless of infiltration. It is recommended that furrowing with this plow be done, in areas where climatic conditions are similar to eastern Iowa, between September 15 and June 1. During this period, there is more likely to be sufficient moisture in the topsoil to permit proper construction of the ridge and to assure continued growth of the loosened sod.

The furrows made by the machine have not been in use long enough to determine entirely their effectiveness. On one pasture furrowed by this plow, however, it was observed that there was no run-off following 4 inches of rainfall in less than an hour, a rain of about 25-year frequency. Furrows without loss of sod, resulting in sodded water furrows and sodded ridges, constitute a distinct advantage, and this plow should become an important item in soil and moisture conservation on pasture land.

Back view of furrowing machine, showing sod in place after ridge is built and packed by concrete rollers.

A second machine has been constructed, consisting entirely of plow parts in stock production. The standard plow bottom used on the original machine is replaced by a 16-inch right-hand sod bottom, and a 16-inch left-hand sod bottom is used in place of the sod cutter and sod lifter. A 10-inch right-hand turning plow bottom is substituted for the original scraper.

Erosion usually must be controlled before soil fertility can be increased.

Grass is an inexpensive, effective weapon that nearly all farmers can use to check soil and moisture losses.

OPPORTUNITIES FOR THE CONTOUR BALK METHOD

By B. H. Hendrickson [1]

THE contour balk method is as yet practiced to only a very limited extent in the Southeastern States. It has evolved gradually as a method by which winter annual legumes successfully maturing seed may be permitted to self-seed the fields year after year, certain summer row crops being grown in wide rows between the ripening legume balks. Winter legumes used in Georgia have been mainly crimson clover, southern spotted-leaf bur clover, hairy and Augusta vetch. Summer crops have been principally corn with cowpeas, soybeans, or velvet beans, and some cotton.

In land preparation for summer crops in wide rows, the general practice has been partially to break the winter legume land by contour turn-plowing outward in single rounds, or "bedding out", leaving unbroken winter legume balks about a foot wide between the plowed strips. Corn is generally planted, 5 to 6 feet apart, in the waterfurrow rows so formed.

In the balks the winter legume seeds ripen in May to early June, the corn being cultivated as usual. At the last corn cultivation, the balks between each pair of corn rows are broken out. This operation scatters the winter legume seeds for a volunteer stand in the fall. Cowpeas may then be interplanted, between corn rows.

A large Georgia farm has used this method continuously for about 15 years, principally in connection with corn and companion summer legumes, on Cecil sandy loam. Now the topsoil is dark-colored and productive, since the organic matter and nitrogen needs have been amply supplied by repeated legume cover cropping and green manuring. The winter cover crops used have been mainly crimson clover mixed with Italian rye grass, both of which have volunteered dependably in the balk plan on this farm. Good contour culture is practiced. In fact, the farmer has plowed out his terraces, claiming they were no longer needed. Crop yields are improving, with less fertilizer used than formerly.

There is little question as to the efficacy of the method in reducing erosion losses to low figures, and improving the soils rapidly. The features include protective winter cropland coverage plus the use of narrow buffer-type temporary contoured resistant strips at very close spacings. The protective effects of the residue materials, good contour culture and summer row crops during the late summer and early fall periods serve to complete the annual cycle of soil protection and soil improvement. Considerable reduction of run-off is probably obtained.

This simple plan of cropland management has many points to commend it. The trouble with it lies, however, in the fact that the average farmer has difficulty in making it work.

The reasons, mainly soils-agronomic in nature, lead back to the well known truism that poor eroded lands produce poor crops. Good farms tend to succeed with winter legumes and a variety of other crops during good and poor seasons; poor eroded farms generally succeed only with drought-resistant poor-land crops and then only in favorable seasons.

Unfortunately, the croplands most in need of the contoured balk method seem unable to use it. Such farms generally depend on cotton, and for this crop it is necessary, for satisfactory yields under boll-weevil conditions, to provide clean, well-prepared seedbeds for rapid early growth. Any practice which interferes with cottonfield land preparation, hinders good germination, or delays growth of cotton, is likely to be discarded as impractical, particularly on small hill farms which are moderately to seriously eroded.

On the other hand, there is little doubt that the contour balk method will work on better croplands on dairy farms, livestock farms, or well equipped farms in general upon which considerable acreage is devoted to production of feedstuffs. Improved winter legumes which grow well and produce seed that does not volunteer until the advent of cool weather are badly needed. If an early maturing type of winter clover can be found which upon ripening will not appreciably compete for soil moisture with seedling cotton growing in nearby rows, then in all probability cotton can enter the contour balk picture. When that time comes, we shall have the makings of a soil conservation method for croplands of far reaching significance.

At the present time many farmers in Georgia are using a variation of the method in a cotton and corn 2-year rotation. Contour balks of winter legumes remain in corn to self-seed for the following winter's stand, the stand being plowed under early the following spring in preparation for cotton.

[1] Superintendent, Southern Piedmont Experiment Station, Soil Conservation Service, Athens, Ga.

THE "SPREAD ROW" SYSTEM FOR LAYING OFF ROWS

By B. L. Taylor [1]

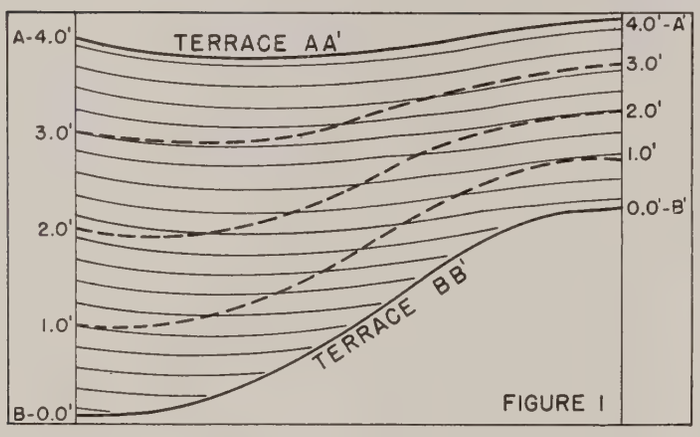


FIGURE 1

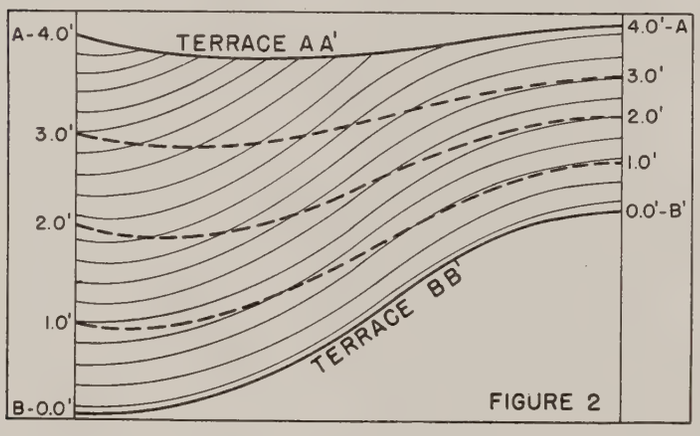


FIGURE 2

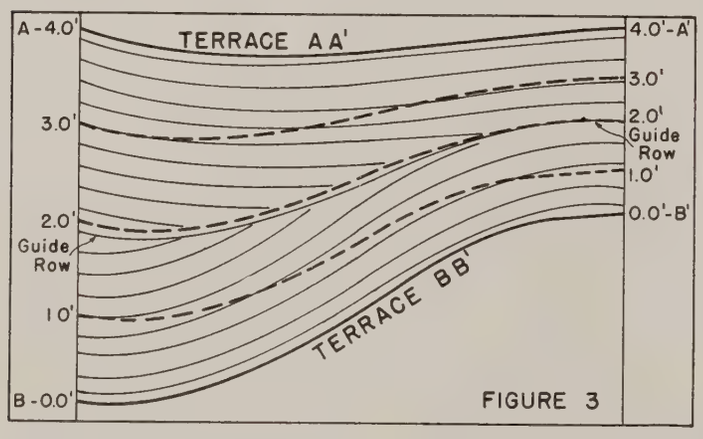


FIGURE 3

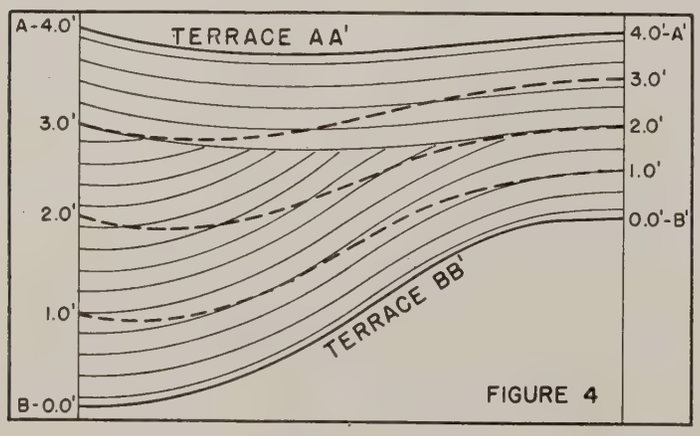


FIGURE 4

AFTER a farmer's fields have been properly terraced, the question he asks most frequently is, "How should I lay out my rows?" The "spread row" system, presented in the following discussion, was worked out in the effort to find a definite answer to that question.

The system is not offered as a final solution to the problem. It is presented rather as a suggested method which may serve as a basis for further discussion and, in the meantime, one which will provide the farmer with a workable plan. Such a system should be flexible, in order that rows can easily be changed when excessive grade or bagging occurs.

One or more places will usually be found in the water furrow of most rows, where a stump, a short high place or other obstruction will prevent flow to the outlet. Or, a break in a row will permit the water to flow from the water furrow to a lower level instead of going to the outlet, as was intended. For these reasons, it is assumed that a row should not be expected to control all of its own water.

The surplus water not able to reach the outlet by flowing along the furrow between the rows, should run at low velocity over the tops of the lower rows on the flatter slopes (between the terraces). These flatter slopes usually will have more topsoil as well as more vegetative cover, thereby being more resistant to erosion than the steeper, more eroded slopes.

Under the spread-row system it is assumed that rows should be on the contour, or should have as little fall as practicable. Ends of point rows should point to the first long row above. Seldom should it be found desirable to lay off point rows in such a manner that one end will be in the terrace channel. The longer point rows of each set should be run parallel to the adjacent long row below.

Guide rows should be laid off with the same grade as adjacent terraces. One guide row at half the terrace interval should divide the area between two terraces into two areas that are approximately equal. Two guide rows should divide the area between two terraces into three areas that are of approximately equal area, etc.

For illustration, consider a segment between two terraces where at one end the slope is such that there

[1] Engineer, Soil Conservation Service, Meridian, Miss.

is a space 18 rows wide; at the other end of the segment the slope is twice as great, but the space is 9 rows wide. Also assume a difference in elevation of the terraces of 4 feet. Then (using the recommended practice of having the crest of the terrace as a "middle"), should the rows be laid off with the terrace above the result would be a system as shown in figure 1.

In figure 1, as well as subsequent figures, the numbers at each end of the segment refer to the probable elevation of different points at the ends of the segment between terraces. The dashed lines are contour lines indicating the probable elevations of different points within the segment.

The vertical interval (difference in elevation) between the points A and B is 4 feet. The vertical interval between A′ and B′ is also 4 feet, but the horizontal interval is considerably less than the horizontal distance between A and B, as can readily be seen in the figure.

Now the vertical interval *per row* at the space A B can be obtained by dividing the total vertical interval, which is 4 feet, by the total number of rows, which is 18 at the space A B. This division of 18 into 4 gives the vertical interval per row at the space A B as 0.22 foot.

Also, the vertical interval per row at the space A′ B′ is obtained by dividing the total vertical interval, or difference in elevation between A′ and B′ which is 4 feet, by the number of rows, which at the space A′ B′ is only 9. Dividing 9 into 4 gives the vertical interval per row at the space A′ B′ as 0.44 foot. Then, at row no. 9, for instance, the elevation at the A B space would be 2.0 feet above terrace B B′, giving a fall in row no. 9 from A B space to A′ B′ space of 2.0 feet. Carrying this discussion one step further, and assuming that the terraces have a fall of 0.1 foot per hundred feet from A′ and B′ toward A and B, respectively, and the distance approximately 200 feet, row 9 would have a fall of 1.8 feet, in the opposite direction from the way the water flows in the terrace channel. Also, should the terraces have 0.1 foot fall per humdred feet from A and B to A′ and B′, respectively, row 9 will have a fall of 2.2 feet, in the 200 feet, but in the same direction as the grade of the row.

Note how rows deviate from contour (dashed) lines in the figure.

Using the same illustration, but laying out the rows parallel to the lower terrace, a system as shown in figure 2 will result.

This system has approximately the same disadvantages as the other, except that silt is not deposited in the terrace channel, as where the rows are laid off as illustrated in figure 1. Also, there will be the disad-

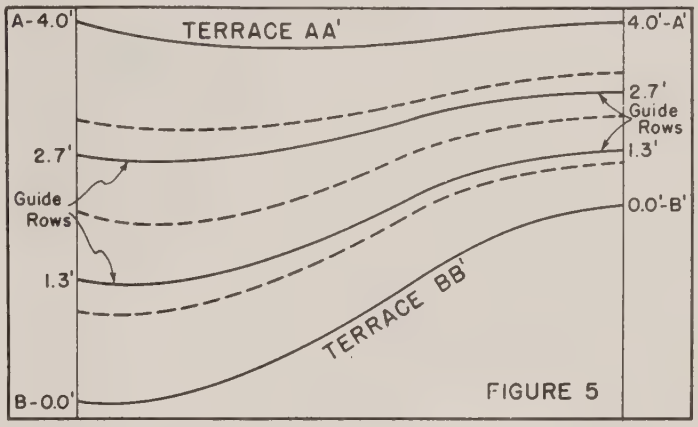


FIGURE 5

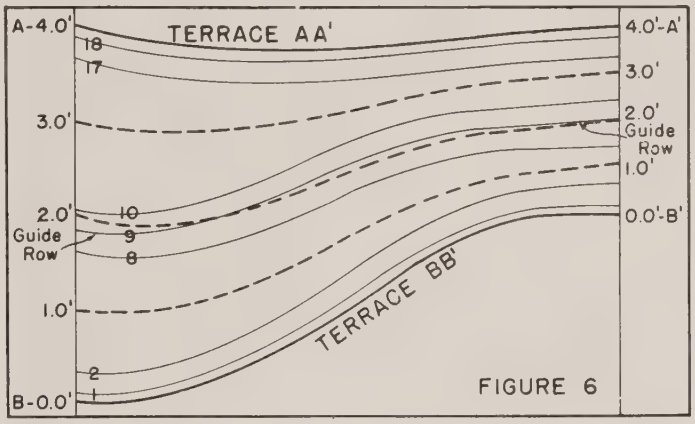


FIGURE 6

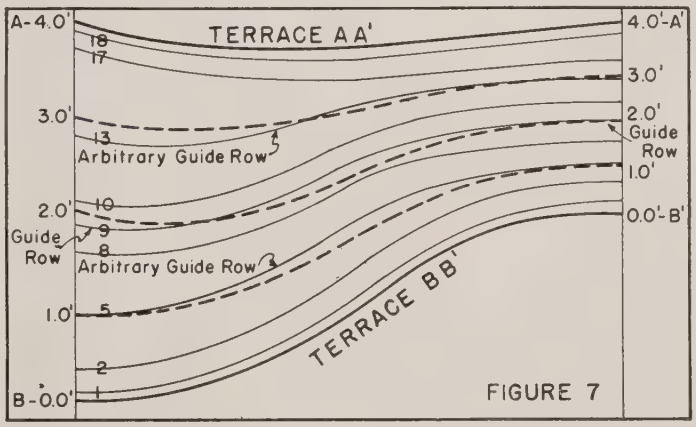


FIGURE 7

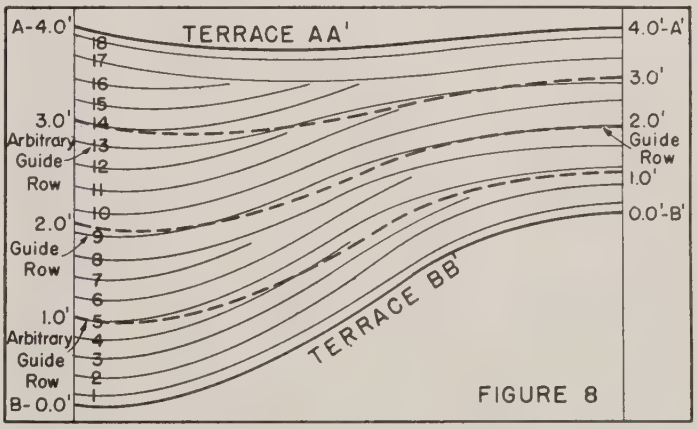


FIGURE 8

vantage that, should the terraces run either way, the surplus water will concentrate on the space A B.

Now, using the same illustration, suppose that a guide row be laid off on the 2-foot elevation between the terraces and the rows be laid off as before. Thus, using both the systems, and running the rows parallel to the upper terrace on the upper part, and parallel to the lower terrace in the lower part, a system as shown in figure 3 will result. By dividing the terrace area as shown in figure 3 into two parts by the guide row, conditions are twice as good as those shown in figure 1 and figure 2, with less deviation from the contour lines.

Figure 4 illustrates the usual system of laying off rows now employed by farmers in the Southeast when no guide row is used.

This system is laid out by laying off the long rows parallel to the upper terrace until half way down to the terrace below in the most narrow place (as A′ B′ space), then laying off the rows parallel to the lower terrace, including both the long and short rows, with the short rows pointing into the long row above. In the absence of the guide row or rows, this is perhaps the best system yet used. One or more guide rows would improve this system considerably.

Referring to figure 5, it is obvious that whichever way the rows are laid off, the results should be at least three times as good as the system illustrated in figure 1 and figure 2, as well as an improvement on the system illustrated in figure 3. This brings the discussion to the point where it would be well to consider the practicability of spreading out the point rows throughout the terrace interval.

By the term, "spreading out the point rows" is meant having the long rows interspersed with point rows, preferably, in two's. An odd number of point rows is undesirable, because in cultivating with one-row cultivators, or one furrow to the row with any plow, the operator must go back to the end of a row to start another row. However, the space on the last part may demand an uneven number of point rows.

Determine from looking over the area between terraces the number of guide rows required. If the area between the terraces is fairly smooth, of about the same slope and not very wide, one guide row may be used. Should the area be rough, or more than twice as wide on the flatter slope as at the most narrow place, two guide rows should be used. Three guide rows may be advantageously used on the more difficult areas. As the procedure is the same for laying out rows according to the spread row system for two or more guide rows as for one, one guide row will be used in the illustration of the practical system of laying out rows on the contour.

Lay off a guide row at the 2-foot elevation, or midway between the terraces. Then lay off two rows below the crest of the terrace above with the top row a half space below the crest of the terrace. Also, lay off two rows above the crest of the lower terrace with the first row a half space above the crest. Now, lay off the guide row with one row on each side, giving the guide row the same grade as would be given if it were run as a terrace. Up to this point, seven rows have been laid off with the system partially completed as shown in figure 6.

Note in figure 6 that the rows 2, 8, 10, and 17 are less accurate than 1, 9, and 18, but will be accurate enough for practical purposes. Also, the rows 1, 2, 17, and 18 will be on part of the terrace and not subject to better treatment.

Now two wide spaces are left. By arbitrarily "splitting each area open" with a furrow, four open spaces of smaller size are left, giving a figure as shown in figure 7.

The so-called "arbitrary" guide rows can be put in by any experienced plow man with fair accuracy and will approximate the accuracy of a guide row.

Figure 8 shows the "spread row" system complete with the point rows worked in. Note how the rows approximately follow the contour lines. The illustration is self-explanatory, showing that two, or at the most three, point rows are in between one or more long rows. When three or less point rows are all the point rows in the system, they should be placed together, about one-third of the distance below the guide row or the terrace above to the guide row or terrace below.

It is found that practically nothing is to be gained by laying off more guide rows than are desirable for guides in laying off the adjacent rows. That is, when the areas have been cut down to such a point that only reasonable judgment is required to complete the system, more guide rows are of no practical advantage. The objective is to put in enough guide rows so that the open spaces will not be too large for the easy distribution of point rows.

This system will work under most conditions. It may be found advisable, however, due to a peculiar slope in some cases, for four short rows, or for all the short rows, to be together. When this seems advisable visualize first how the rows would run on the "spread row" system in order to be sure that laying off all the rows together would be an improvement.

Advantages in the "Spread Row" System

1. Rows are on approximate contour without excessive fall or bagging.

2. This is a flexible system. A short or point row can easily be connected into an adjacent long row if excessive fall or bagging is found. This condition will usually be found at or near the end of point rows.

3. In heavier rains slight bagging is found, and is desirable, on the flatter slopes, since it helps protect the steeper and the more eroded part of the area. Surplus water will run along the water furrows of the steeper slopes before running over the tops of the rows on the flatter slopes. It will run over the tops of the rows on the flatter more protected ground before escaping over the tops of the rows on the steeper ground.

4. Ends of the rows point to the first long row above.

5. This system is not designed with the expectation that the rows will carry all of their own water to the outlet, although most of it will go along the water furrow to the outlet if the row is reasonably high and if there are no obstructions in the water furrow.

6. No rows are pointed into the terrace channel.

7. Point rows are run parallel to the adjacent long row below.

8. When there is an odd number of point rows in the system, the shorter one is the odd one when cultivating with one furrow to the row and working to the top of the slope.

It is true that more spaces are encountered in this system than in other systems now in use where narrow places in the row are necessary. This condition can be alleviated by making several of the rows adjacent to the narrow space somewhat more narrow than standard. By using this treatment, this condition will not be so noticeable.

In some cases, it will be found that there will be a few more point rows than when the rows are laid off according to present practices.

After laying off one or two areas between terraces, it will be found that the system is easily understood and is not difficult to execute. For best results, however, this work could hardly be entrusted to cheap or careless labor.

CONTROL OF SOIL DRIFTING IN CANADIAN WEST

By A. H. Joel [1]

FOR several decades wind erosion has been a serious problem in that part of the Canadian West which lies at the northern extremity of the Great Plains. During recent years of severe droughts this type of erosion, called "soil drifting" in Canada, has become an issue of national concern, with the result that a highly interesting and energetic control program is now under way. A brief résumé of observations made while in Canada last June may give some idea of the methods employed in the program as set up by the Prairie Farms Rehabilitation Act.

Wind erosion in the Canadian Provinces occurs chiefly on extremely light or extremely heavy soils which have been summer-fallowed for spring wheat; and in recent years serious drifting has been noted on many soils of intermediate texture where summer fallowing is practiced. Control methods center largely around strip cropping, the use of trash cover, plowless fallow, and cover crops.

Strip cropping has long been practiced in certain districts of southern Alberta and today is being adopted throughout many other areas. Stripping is usually started on a field in the year when it is to be fallowed. Strips of the desired width are laid out and alternate strips are seeded to spring grain, leaving the other strips to be fallowed. Widths of strips vary with soil type and other conditions, but they are usually 10 to 20 rods wide, and on light soils may be as narrow as 5 rods.

It is recognized that in most instances strip cropping alone is not adequate for the control of soil drifting. Suitable cultural practices must be followed, particularly those designed to secure as much trash cover as is possible and to maintain the soil in a lumpy condition. "Trash cover" refers to the stubble of grain and weeds and other organic residue left anchored in the surface soil in such a manner as to prevent it from blowing away. A good trash cover is made possible by the "plowless fallow" and is very effective in checking soil blowing.

The plowless fallow is merely a summer fallow worked with such implements as the one-way disk, the rod weeder, and the duckfoot cultivator. The aim is to check weed growth—for moisture conservation—without burying the various organic residues or releasing their anchorage in the soil. A field so worked is anything but neat, but the result in crop yield more than justifies the practice. The combination of strip cropping with a good trash cover, when properly fallowed, holds great promise for wind-erosion control in western Canada.

In localities where there is a fair amount of rainfall, a late cover crop on the summer fallow provides good protection. With this method a spring grain is seeded in the late summer, preferably the same kind and variety of grain chosen for the fallowed land during the coming crop season. In favorable years the cover crops frequently make sufficient growth to permit pasturing.

A promising research program dealing primarily with wind erosion has been launched in western Canada, and it will be interesting to note its progress. The center of the program is at the Dominion Experimental Farm at Swift Current, Saskatchewan, where an excellent soils laboratory has been constructed. Many field and laboratory investigations are planned, some already under way. New types of farm implements are being developed to provide suitable methods of cultivation. One of the most interesting developments along this line is a blade-type implement designed to kill young weeds without seriously disturbing the anchorage of dead stubble.

A "wind tunnel" for laboratory studies and a "wind machine" for field studies, both in relation to wind erosion, also hold real promise. The latter machine is essentially an airplane propeller mounted for mobile field use and arranged to create strong air currents between lateral "walls" of board. The plan is to use this machine under varying conditions of soil, vegetation, etc. The "wind machine" and "wind tunnel" are considered first steps in the development of adequate apparatus for extensive studies in field and laboratory in connection with wind erosion.

---

[1] Senior Soil Scientist, Soil Conservation Service, Washington. D. C.

SOIL-EROSION PROBLEMS ON IRRIGATED FARM LAND

By Dana F. Kirkmire [1]

THE menace of soil erosion presents a very serious problem for the farmer on irrigated farm land. The erosion of irrigable land will never create the widespread devastation it has wrought in other localities, notably the "Dust Bowl" in the Southwest; but its effects on the individual farm may be no less acute and serious. For the most part, soil erosion caused by wind on irrigated land is a problem peculiar to a particular farm rather than to a whole section of the country. To illustrate, one farmer may have his seeding blown out of the ground two or three times in one season, while his neighbors may not experience this trouble at all because of different soil types or different cropping practices. Thus, the effects of soil blowing, as an example, may be noticeable only on a farm or two in a given area and thus not arouse much interest or publicity. But at the same time the particular farm where the blowing occurred, and others adjacent which received the deposit of soil, may be ruined.

Wind, gully, and sheet erosion all occur in varying degrees on irrigated farm land within the Shoshone Indian Reservation of Wyoming. A few of the problems encountered and means of controlling and correcting the many factors causing erosion in the particular area are described in this article.

A Land of Sparse Vegetation

Much of the land brought under irrigation by the Reclamation Service and thus made accessible to farming is ordinary arid range land, and the most conspicuous plant cover is sagebrush. Never heavily vegetated, even in ages gone by, this land has received very little organic matter from decayed plant life. Because of its lack of organic material, the topsoil possesses far less moisture-storing capacity than its texture would indicate, and the little moisture available from precipitation is used up by the vegetation it supports, or immediately runs off if the vegetative cover has been depleted. Thus, when the sagebrush and native grass cover is removed by the farmer preparatory to seeding his first crop under irrigation, the soil lies ready to be moved by the wind. The same is true also following the harvest of clean-tilled crops such as sugar beets and beans.

Drift of snow and topsoil from land from which native grass and sagebrush was removed only a few months previously. (Picture taken February 4, 1937.)

Prevent Blowing

To prevent the removal of the topsoil by the wind, the Soil Conservation Service has found that native vegetation should not be disturbed until just prior to seeding time, usually in the spring. Windbreaks along the windward sides of fields subject to blowing are recommended with a view to longtime protection. The windbreaks now being established consist of 3 to 5 rows of trees spaced 6 feet apart in the rows. The species of trees are mainly Russian olive, Chinese elm, green ash, honey locust, box elder, and caragana. It is highly probable that were sufficient tree windbreaks established on all the farms needing them, their cumulative effect in years to come would greatly alleviate wind erosion.

As a control measure after blowing has started, listing is a good practice. This, however, is not entirely successful, as once the soil starts moving it apparently can be stopped only by cessation of the wind. The best method of controlling wind erosion is to prevent it from starting.

Aside from the effects upon a given field of the removal of its topsoil, other serious damages result from unimpeded blowing—irrigation ditches are filled, fences are drifted over and rendered ineffective, and drifts pile up around buildings and corrals.

Faulty Irrigation and Gullying

The seriousness of gully erosion on irrigated land is generally more striking to the eye than any other type. Numerous places may be seen in any irrigated district where ditches have "broken out" and permitted the water to flow across the land below, quickly resulting in deep unsightly gashes. Faulty irrigation likewise may cause far greater but less obvious damage. Irrigation water will cut severe gullies in ditches which

[1] Assistant forester, Soil Conservation Service, Lander, Wyo.

Downstream end of same gully as below. The photographer stood in the main gully, which is 20 feet deep and 50 feet wide. This gully was caused by the water spilling from the end of several main irrigation laterals.

have too great a fall since, naturally, the greater the "head" of water in the ditch the greater its erosive capacity. The same factors which apply to water in a ditch are equally applicable to water running between crop rows or even over grain or alfalfa. If the slope is steep—over 5 or 6 percent in the case of row crops—and too much water is turned on to the ground, gullies will be the result.

The most striking gullies on irrigated land, however, are those caused by so-called "waste" water. While a field is being irrigated if the amount of water which runs down across the field is not judged accurately for proper absorption by the soil the excess must run off to other ground. If it runs on to a tract of native sagebrush land with characteristic insufficient vegetation, the waste water will run together in the low places and wash gullies across the sagebrush land. Repeated irrigatings of the original field with the resultant "waste" water will keep these gullies eating back until they encroach on the crop field. Serious damage to the field and to the farm as a whole will be the consequence. The same applies if the water is "wasted" on to cropland below without water-spreading ditches and proper vegetative cover to take care of it.

Sloughing Off

The dead-ending into natural drainageways of the main irrigation ditches supplying a number of farms likewise results in severe gully bank eroison for those farms bordering on the natural drainageway. These main ditches pour a quantity of water in varying amounts down the drainageway all during the growing season, creating a live stream. The banks of the drainageway are covered with only the very meager vegetation of arid conditions, offering practically no holding protection. The result is that the water undermines the bank first on one side and when that sloughs off it shifts to the other side and undermines it with the resultant sloughing and so on. Thus a relatively small stream of water will in a very short time cause an enormous gully which continually keeps enlarging and eating away farm land. Lee Harrison, a cooperator on the Shoshone project, estimated that in 1936 he lost over an acre of crop land within a quarter of a mile along one side of such a drainageway.

Proper System to Prevent Gullying

In the Soil Conservation Service program, a proper water distribution system with a minimum of "waste" water is surveyed by the engineers and constructed by the cooperator. This compares with the installation of contour-tillage practices on farms dependent on precipitation for crop production in other projects. The distribution of irrigation water is not so simple as it seems, as careful planning is required to secure a practical and economical system. Ditches carrying water usually should not have a fall in excess of one-tenth or two-tenths foot to each 100 linear feet. Where the ditches must descend steeper slopes than the above, it is necessary to construct "drops" to prevent gullying. Subsequent spreader or "pick-up" ditches must be made at intervals varying according to slope and soil type across the field. Determining the proper intervals for these "pick-ups" or "laterals", as they are called, is one of the most important factors in laying out the irrigation system. If they are spaced too far apart, water running over the slope from the ditch above will cause gullying and sheet erosion even when the slope is only moderately steep. Also, the ground immediately below the upper ditch will become soaked excessively before the water "gets through" to the lateral below, and, in time, "seep" conditions will occur with heavy accumulations of alkali rendering the ground unproductive and entailing great expense for draining and reclamation. If the

(Continued on next page)

Upstream end of gully in native cover caused by waste water from an irrigated field above.

ARTICLES ON FLOOD CONTROL AND RESERVOIR STUDIES IN SOIL CONSERVATION, VOLUMES 1 AND 2

Agriculture's New Approach to Flood Control. A. L. Patrick. Vol. 2, No. 11, May 1937 issue. pp. 245–246, 266.

Agronomy's Contribution to Flood Control and Drought Relief. C. R. Enlow. Vol. 2, No. 9, March 1937 issue. pp. 191–192, 200, 214.

"Brushing Out" the Banks of Streams. C. F. Stewart Sharpe. Vol. 2, No. 10, April 1937 issue. pp. 221–224.

Changes in Atmospheric Circulation Result in Floods. B. Holzman and K. Clarke-Hafstad. Vol. 2, No. 11, May 1937 issue. pp. 254–255, 266.

Dams Impound State's Water Against Time of Drought. L. C. Tschudy. Vol. 1, No. 2, September 1935 issue. pp. 11, 14.

Detention Reservoirs for Gully Control. Dwight D. Smith and Emerson Wolfe. Vol. 1, No. 4, November 1935 issue. pp. 12–13.

Dr. Bennett Talks on Flood Control. H. H. Bennett. Vol. 2, No. 1, July 1936 issue. pp. 2–6.

Erosion Defenses Withstand Pounding of Record Rains. Harold G. Anthony. Vol. 2, No. 3, September 1936 issue. pp. 41–43, 57.

Flood Control Work in Italy. Albert Chiera. Vol. 1, No. 10 May 1936 issue. p. 15.

Flood Menace and Erosion Problem Challenge Scientists of Many Fields. Vol. 2, No. 5, November 1936 issue. pp. 87–94.

A Formula for Capacities of Reservoirs. G. C. Dobson. Vol. 1, No. 7, February 1936 issue. pp. 7–9.

From Farm Fields to City Streets. Carl B. Brown. Vol. 2, No. 9, March 1937 issue. pp. 189–190, 198.

A Gila River Gone Berserk. E. Edgar Fuller. Vol. 1, No. 3, October 1935 issue. pp. 12–13.

How Main Street Became the Big Ditch. Ross Calvin. Vol. 2, No. 5, November 1936 issue. pp. 102–105.

Meeting the Menace of Overflow Water. Henry M. Eakin. Vol. 1, No. 6, January 1936 issue. pp. 5–6.

One Angle of the Flood Problem. Vol. 2, No. 8, February 1937 issue. p. 186.

Reservoir Silting in the New River Watershed. Carl B. Brown and F. F. Barnes. Vol. 2, No. 5, November 1936 issue. pp. 95, 106–107.

Reservoir Silting Results From Preventable Erosion, Survey Shows. Vol. 1, No. 3, October 1935 issue. pp. 6–7, 14.

Silt Measurements During Potomac River Flood. Vol. 1, No. 10, May 1936 issue. p. 14.

Stock Ponds in the Great Plains Drought Area. W. C. Lowdermilk and F. F. Barnes. Vol. 2, No. 3, September 1936 issue. pp. 44–47, 58.

Studies of Reservoir Silting. Carl B. Brown. Vol. 1, No. 10, May 1936 issue. pp. 1–5, 14.

Traveling Soils—An Erosion Surveyor Views the Flood Zone. Mark H. Brown. Vol. 2, No. 11, May 1937 issue. pp. 252–253, 267–268.

Utilization of Small Water Powers. H. H. Bennett. Vol. 2, No. 4, October 1936 issue. pp. 74–80.

Watershed Control in Italy. Arthur C. Ringland. Vol. 2, No. 11, May 1937 issue. pp. 251, 265–266.

Watershed Treatment and Flood Control. R. H. Davis. Vol. 2, No. 11, May 1937 issue. pp. 247–250.

Weighing the Costs of Flood Control. Walter J. Roth. Vol. 2, No. 9, March 1937 issue. pp. 201, 207.

Soil-Erosion Problems on Irrigated Farm Land

(Continued from preceding page)

"pick-ups" are too close together, the irrigating of the field becomes prohibitive in cost, to say nothing of the unproductive area of the ditches themselves. A field on which a proper irrigation system is established looks very similar to one which has been contour furrowed, as the gradient in the laterals is not noticeable to the eye.

The prevention of "sloughing off" of banks along drainageways has not yet been satisfactorily solved, and cannot be solved except by reducing the volume of the waste water which causes the gullies. Only conservative use of water will avoid the distressing damage caused by the surplus turned loose to seek a course to the sea. The irrigationist must learn the fundamental truth, that he is dealing with a destructive as well as a life-giving agent. It is possible to gage more correctly the amount of water required and thus prevent the accumulation of a surplus to destroy the neighboring landscape. The control of surplus or waste water on irrigation projects is one of the most challenging problems facing an irrigation district.

Topsoil Losses Under Faulty Irrigation

A form of sheet erosion occurs under the irrigation practice known as "flooding", and also even where the more desirable system of "corrugating" is used. The amount of sheet erosion which takes place under either of the above methods varies with the slope, texture of the soil, and, most important, the "head" or quantity of water used. Other conditions being equal, if too large a "head" is used the water carries from the irrigated field a quantity of topsoil similar to that lost after a heavy rain under unirrigated conditions. Gullies may or may not be formed, and the soil loss is only evidenced by the increasing unproductiveness of a field and the accumulations of silt on fields below. A notable example of sheet erosion occurred on the Shoshone project during 1936 when one farmer washed a whole field of his seeding down on to a field below where the crop was grown. This practice has given rise to the remark that in irrigated country a farmer often has to buy the "40" below him to get back his topsoil.

Rotation Essential

On the Shoshone project, sheet erosion in combination with wind erosion has complicated crop production on new land brought under irrigation in that, through prior depletion of the vegetative cover, as much as 75 percent of the original topsoil has been removed. Thus careful crop rotation systems must be

(Continued on p. 116)

Introduced Plants in Erosion Control

Following is a list of important introduced trees and shrubs used in erosion control. It is by no means complete but it indicates a wide range of origins, together with the principal Soil Conservation Service regions in which these plants are being used to check soil losses. The list below includes many plants which were not noted in the back-cover sketches of the March and July issues of SOIL CONSERVATION.

Species	Common name	Place of origin	Used by S. C. S. in region—
CONIFERS			
Larix europa	European larch	Europe	1, 5, 11
Pinus halepensis	Aleppo pine	Europe and Asia Minor	8, 11
Pinus nigra	Austrian pine	Europe	3, 5, 7, 9, 11
HARDWOOD TREES			
Acer platanoides	Norway maple	Europe and Siberia	8, 9
Eucalyptus corynocalyx	Sugar gum	Australia	10
Eucalyptus globulus	Blue gum	do	10
Eucalyptus leucoxylon	White ironbark	do	10
Eucalyptus rostrata	Creek gum	do	10
Eucalyptus rudis	Desert gum	do	10
Eucalyptus tereticornus	Slaty gum	do	10
Eucalyptus viminalis	Manna gum	do	10
Fagus sylvatica	European beech	Europe and Siberia	11
Morus alba	White mulberry	China	1, 2, 3, 4, 5, 7, 8
Prunus armeniaca	Apricot	Asia	6, 7
SHRUBS, ETC.			
Alnus glutinosa	European alder	Europe	11
Artemesia abrotanum	Southernwood	do	11
Asparagus officinalis	Asparagus	do	7, 8
Calluna vulgaris	Heather	Europe and Asia Minor	11
Celastrus orbiculatus	Oriental bittersweet	Japan and China	3
Colutea arborescens	Bladder senna	Europe and Africa	8
Corylus avellana	Filbert	Europe	1, 11
Cytisus scoparius	Scotch broom	do	2, 11
Elaeagnus reflexa	Bronze elaeagnus	Japan	2
Elaeagnus umbellata	Autumn elaeagnus	China and Japan	2
Ephedra sinica	Mahuang	China	8
Iris germanica	Iris	Europe	2, 8
Lespedeza bicolor	Shrub bushcover	Japan	1, 2, 5
Lespedeza cyrtobotra	do	do	1, 2, 5
Lespedeza juncea	do	China and Siberia	1, 2, 5
Lespedeza sericea	Perennial lespedeza	China and Japan	1, 2
Ligustrum vulgare	European privet	Europe and North Africa	11
Lonicera maacki	Amur honeysuckle	Siberia and Japan	2
Lonicera morrowii	Morrow honeysuckle	Japan	7
Lonicera ruprechtiana	Manchurian honeysuckle	Manchuria	2
Lonicera tatarica	Tatarian honeysuckle	Siberia	1, 3, 5, 7, 9, 11
Lonicera xylosteum	European fly honeysuckle	Europe and Asia	2, 3
Lycium halimifolium	Matrimony vine	China	1
Rosa multiflora	Japanese rose	Japan	2
Rosa wichuriana	Wichurian rose	do	1
Rosa rugosa	Rugosa rose	Japan and China	2
Rubus parvifolius	Japanese trailing raspberry	Japan	1, 2, 3, 4, 5, 7, 8
Rubus thyrsanthus	Hamalaya blackberry	Europe	2, 4
Viburnum opulus	European cranberry	do	3
Vitex agnus-castus	Chaste tree	Europe and Asia Minor	2
Zizyphus jujuba	Jujube	South Asia	6, 7, 8

BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

MOISTURE AND FARMING IN SOUTH AFRICA. By W. R. Thompson. Johannesburg, South Africa. 1936.

A great deal of the literature which has been prepared in the United States on various conservation subjects is being carefully reviewed and adapted in South Africa. Now, in turn, investigators in this country have the opportunity to review, in Mr. Thompson's book, the preliminary studies concerning certain aspects of moisture supply and moisture dissipation in South Africa during the historic period. Aside from its wealth of data it is a thought-stimulating book and the experiments presented, although essentially South African, will be found to have an especial bearing on our problems—those of the Great Plains in particular.

It is apparent that the author, who is senior lecturer in agronomy at the University of Pretoria, has made extensive studies of the moisture conditions, present and past, of South Africa. It is apparent, also, that, in his opinion, the progressively drier aspect of his country is not due to definite climatic changes but to the greater demand for moisture and to the acceleration of run-off under modern intensive agricultural conditions. In fact, it might be said that the theme of the book is a refutation of the alleged drying up of the southern part of the African continent coupled with a defense of and a plea for soil- and water-conservation programs to fit the various regions and based on research studies and scientifically planned.

Throughout a long discussion of hydrological conditions all available information concerning moisture and its dissipation is assembled and analyzed, and voluminous references are cited as historical evidence in support of the necessity for a permanent adjustment of agriculture to natural environment.

A particularly interesting feature is the many and varied facts and theories which come to light in connection with South African climatic factors. For example, in an account of Schwartz's scheme to redivert water into the Kalahari lost lake system, the reader learns that severe droughts occurred long before the waters of the lakes were captured by the Zambesi. One is interested also to know that the Hottentot word "Karroo", applied to the arid region for many centuries, means aridity; that the Karroo flora is all very highly specialized, all plant organs being constructed either to store water or to pervent its loss through evaporation; that precipitation over South Africa is caused by world-wide atmospheric movements, not by local influences such as the Kalahari lakes. In fact, when Mr. Thompson and the reader have finished with the "Kalahari scheme", there is no doubt in the mind of the latter regarding the impractability of the much publicized plan to banish aridity from the southern part of the African continent by "restoring" the lost lake system.

Other theories which have been advanced from time to time in connection with the alleged drying up of southern Africa are discussed also. With regard to vegetal cover and moisture supply the author states that "the relation of the vegetal cover to the economic and effective utilization of rain water is undoubtedly a cardinal point in the amelioration of the drought problem in South Africa." This means, apparently, that bare spaces from deforestation, firing, and overgrazing induce evaporation from the soil and increase run-off and insipient erosion.

In a chapter presenting historic evidence regarding climatic conditions are to be found interesting accounts of irrigation farming throughout the past century, of the Bantu races with their nomadic habits, and game migrations as influenced by severe droughts and irregular, intense rain storms, of the trekking system of stock farming suitable to the climate, and of the periodical drying up of rivers throughout the past two or three centuries. In this chapter is also a section pointing out the significance of place names and Bantu expressions with regard to climatic conditions of the past.

That part of the book which deals directly with rainfall data, rainfall intensity, soil erosion and run-off, evaporation and percolation, no doubt will become an extremely valuable reference to students throughout the world who are investigating the factors affecting moisture supply and dissipation. Here all available data regarding the secular variations in South African rainfall, with their agricultural aspects, are brought together and presented in tabular form and in charts and maps. In his dicsussions accompanying the data, the author builds up vigorous and convincing arguments in favor of long-term forecasting systems to reduce losses due to periodic drought, to reduce overstocking, veld burning, and soil erosion, to increase crop production and indirectly to improve the soil iteslef. Some significant facts emerge from Mr. Thompson's description of run-off experiments conducted in 1931–35 at the Pretoria University experimental farm. The resultant data are described as unique in that they are the first of the kind to be obtained in South Africa from a properly controlled experiment. Unused veld was shown to prevent run-off and soil erosion almost entirely; Kraal-manure, when applied to maize, effected a considerable decrease in run-off (indicating the importance and effect of organic matter in run-off control); the run-off on burned veld was 27 times greater than that of a natural veld plot during a good rainfall season; Teff grass as an unusual hay crop prevents excessive erosion but permits run-off at planting time and during the establishment period; Rhodes grass used as a perrennial planted grass was most effective in preventing run-off and soil erosion; loss of water and soil respectively was 80 to 683 times greater from the uncultivated bare plot as compared with that from the veld intact plot.

Initial investigations regarding the roles of evaporation, transpiration, and percolation in the dissipation of moisture in South Africa are described in detail and the results obtained cast new light on the replenishment of the subsurface water supply and the lowering of the water table in recent years. Emphasizing the need for extensive studies along this line the author states that "all factors affecting the moisture cycle are clearly interrelated and cannot be divorced from one another. Evidently the interpretation of any one factor without due regard to the influence of the others cannot give a true perspective of the position. The need for comprehensive research in this field also cannot be over-emphasized, since, until more data . . . have accumulated, many problems will remain obscure on the moisture problem in South Africa."

The ecological, hydrological, and management aspects of veld burning, an "age-old practice in South Africa", are treated at some length, and the chapter devoted to this mooted subject constitutes a thought-provoking study. The reader who is told that "indirect evidence, collected in different parts of the country and at different periods indicates . . . that the indiscriminate burning of vegetation has led to extensive ecological changes in the flora", that "results, as far as they go, confirm the general opinion that burning is detrimental from the hydrological point of view", and that "controlled veld burning is often a necessary practice in veld management as a means of disposing of old surplus vegetation of fibrous, unpalatable character and of low feeding value" cannot but agree whole-heartedly with Mr. Thompson when he writes that "the need for further research and experimentation on veld burning cannot be over-emphasized."

This book, the result of 5 years of hard work, cannot but prove profitable reading for students of moisture dissipation and agricultural practices in the agricultural countries of the world.

Irrigated Land

(Continued from p. 114)

worked out and practiced on each farm. Row crops are being restricted and alfalfa and sweetclover are plowed under for green manure, and for many years to come rotations must be used to build up and restore fertility to the soil rather than to deplete it. The financial condition of most of the landowners makes it necessary for them to have some acreage in cash crops to meet current obligations, and at the same time necessitates careful planning on the part of the farmer, the agronomist, and the conservationist, in formulating the cropping plan.

U. S. GOVERNMENT PRINTING OFFICE: 1937

Hydraulics, Hydrology, and Water Conservation Studies[1]

For REFERENCE
Compiled by Mrs. ETTA G. ROGERS, Publications Unit

Field offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

Soil Conservation Service

Influence of Vegetal Cover in Flood Control: A Panel Discussion. W. C. Lowdermilk. mm. May 1937.

Water Intake of Saturated Soils. W. C. Lowdermilk. Paper given for Section of Hydrology, American Geophysical Union Meeting on April 29, 1937. mm.

Agricultural Experiment Stations

Aqueous Vapor Pressure of Soils. Reprint from Soil Science, Vol. XI, No. 6, June 1921. Agricultural Experiment Station, Logan, Utah.

Deficiencies in Present Water Resources Information. Publication 3. College of Engineering, New York University, New York, N. Y. 1935–36.

Ground Water Problem in Oregon. Circular 124. Agricultural Experiment Station, Corvallis, Oreg. 1937.

Influence of Depth of Ground-Water Level on Yields of Crops Grown on Peat Lands. Bulletin 330. Agricultural Experiment Station, University Farm, St. Paul, Minn. August 1936.

Influence of Soil Characteristics on Drainage and Irrigation Practices. Reprinted from Soil Science Society of America, Proceedings, 1. 1937. R–355. Agricultural Experiment Station, Logan, Utah.

Quality of the Waters of Southeastern Nevada, Drainage Basins and Water Resources. Bulletin 136. Agricultural Experiment Station, Reno, Nev. July 1934.

Rate of Water Evaporation in Texas. Bulletin 484. Agricultural Experiment Station, College Station, Tex. November 1933.

Soil Erosion—A Local and National Problem. Research Bulletin 99. Agricultural Experiment Station, Madison, Wis. August 1930.

Surface and Sub-Surface Waters of the Yakima and Klamath Reclamation Projects. Bulletin 228. Agricultural Experiment Station, Pullman, Wash. July 1928.

Water Application Efficiencies in Irrigation and Their Relation to Irrigation Methods. Reprinted from 20th Biennial Report of Utah State Engineer. July 1934 to June 1936. Reprint R–348. Agricultural Experiment Station, Logan, Utah.

Miscellaneous

An Analysis of Unusual Precipitation Records in Iowa. Reprint from Journal of the American Water Works Association, Vol. 27, No. 2, February 1935.

Current Hydraulic Laboratory Research in the United States. Periodical. National Bureau of Standards, U. S. Department of Commerce. mm. Issued twice yearly.

Deficiencies in Basic Hydrologic Data. Water Resources Committee, National Resources Board. September 1936.

Drainage Policy and Project. Special Subcommittee of Water Resources Committee, National Resources Committee. mm. February 1936.

Engineering Procedure as Applied to Flood Control by Reservoirs, with Reference to the Muskingum Flood Control Project. The Engineer School, Fort Belvoir, Va. 1936.

Excessive Rainfall in Texas. Bulletin 25. Reclamation Department, State of Texas, Austin, Tex. November 1934. $2.

Forest and Stream-Flow Experiment at Wagon Wheel Gap, Colorado. Supplement 30, Monthly Weather Review, W. B. 946. U. S. Weather Bureau. 1928.

Fundamental Hydrologic Considerations for the Design of Impounding Reservoirs in the Middle West. Reprint from Journal of American Water Works Association, Vol. 28, No. 2, February 1936.

Hydraulics of the Miami Flood Control Project. Part VII, Technical Reports, Miami Conservancy District, Dayton, Ohio. 1920. $1.

Hydrologic Interrelations of Water and Soils. Robert E. Horton, Consulting Hydraulic Engineer, Voorheesville, N. Y. mm. November 1936.

Influence of Deforestation Upon Stream and Valley Resources. Reprint from Journal of Forestry, Vol. XXXIV, No. 11, November 1936.

Practical Aspects of Flood Control and Reclamation of Overflowed Land. Bulletin 27. Texas Reclamation Department, Austin Tex. 1935.

Rainfall and Runoff in the Miami Valley. Part VIII, Technical Reports, Miami Conservancy District, Dayton, Ohio. 1921. 75c.

Report of the Special Advisory Committee on Standards and Specifications for Hydrologic Data. National Resources Board. November 1935.

Report on Water Use and Conservation in the Des Moines, Skunk, and Southeastern River Basins in Iowa. Iowa State Planning Board, Ames, Iowa. mm. August 1936.

Reports and Papers, Hydrology—1933, Section of Hydrology, Transactions of the American Geophysical Union, Fourteenth Annual Meeting. $1.

Reports and Papers, Hydrology—1934, Section of Hydrology, Transactions of the American Geophysical Union, Fifteenth Annual Meeting. $1.50.

Reports and Papers, Hydrology—1935, Section of Hydrology, Transactions of the American Geophysical Union, Sixteenth Annual Meeting. $1.50.

Reports and Papers, Hydrology—1936, Section of Hydrology, Transactions of the American Geophysical Union, Seventeenth Annual Meeting. $2.

Role of Vegetation in Erosion Control and Water Conservation. Reprint from Journal of Forestry, Vol. XXXII, No. 5, May 1934.

Scientific Aspects of Flood Control. Occasional Publication 3. American Association for Advancement of Science, Supplement to Science, Vol. 84. October 1936. 50c.

[2] Silt Theory of Flow of Water, by Radha Krishna Khanna, Assistant Engineer, Punjab Irrigation. Rajar, District Gujrat, India. October 31, 1935.

Some factors Which Modify the Rate and Total Amount of Infiltration of Field Soils. Reprint from Journal of American Society of Agronomy, Vol. 28, No. 9, September 1936.

Storm Rainfall of the Eastern United States. Part V, Technical Reports, Miami Conservancy District, Dayton, Ohio. 1917, revised 1936. $1.50.

Streamflow Experiment at Wagon Wheel Gap, Colorado. Supplement 17, Monthly Weather Review, W. B. 757. U. S. Weather Bureau. 1922.

Studies in the Role of Forest Vegetation in Erosion Control and Water Conservation. Reprint B7. 17, Fifth Pacific Science Congress.

Surface Runoff Phenomena. Part I—Analysis of the Hydrograph. Publication 101. Horton Hydrological Laboratory, Voorheesville, N. Y. February 1, 1935.

Watershed and Other Related Influences and a Watershed Protective Program. Separate 5 Senate Document 12 from "A National Plan for American Forestry", a report prepared by the U. S. Forest Service in response to S. Res. 175 (72d Congress).

Water Sources and Watershed Protection Problems of Oregon Municipalities. Oregon State Planning Board, Portland, Oreg. mm. February 15, 1937.

Superintendent of Documents

(Available by Purchase at the Prices Shown)

Drainage Basin Problems and Programs. National Resources Committee. December 1936. $1.50.

Occurrence of Ground Water in the United States, with a Discussion of Principles. U. S. Geological Survey Water-Supply Paper 489. 1923. 60c.

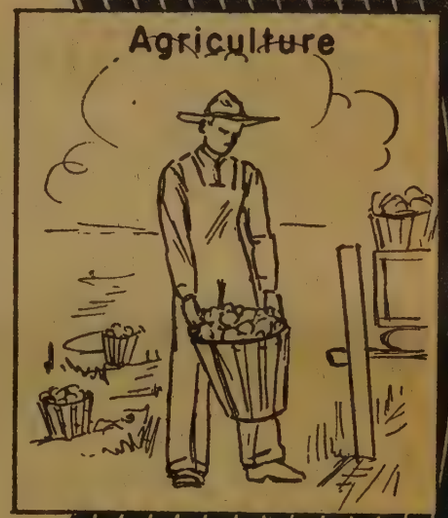
[1] Additional hydraulic and hydrologic references are listed in previous issues of "Soil Conservation" on the inner-back cover, particularly Volume 2, Nos. 5 and 9.

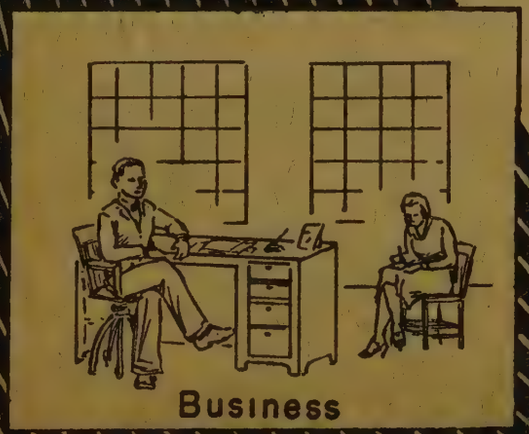
[2] Available only on a loan basis from the Service Library.

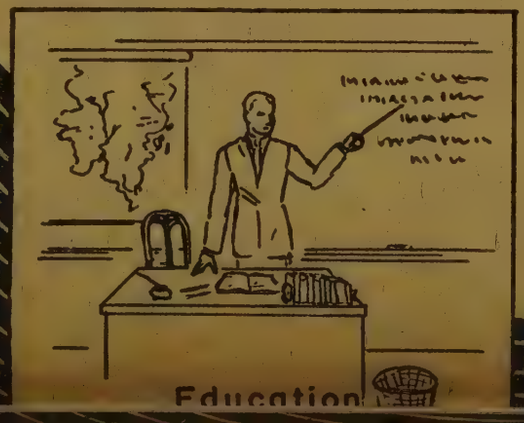
COOPERATIVE CIRCLE

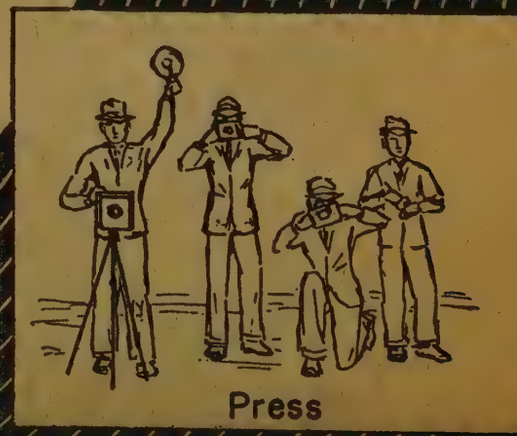
necessary for a successful

SOIL CONSERVATION PROGRAM









SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE · WASHINGTON

NOVEMBER
1937

A VEHICLE FOR EROSION CONTROL

Contents

Page

Society and the Farmer Have Mutual Interests in the Land:
By M. L. Wilson 117

State Legislation for Erosion Control:
By Philip M. Glick 120

The Next Step: Emphasis Shifts to the Districts Plan:
By Dillon S. Myer 126

Chart 130, 131

Associations Lay Groundwork for Legally-Constituted Districts:
By J. Phil Campbell 132

The First District: North Carolina Leads the Way:
By I. O. Schaub 135

Rural Zoning Improves Land Use in Wisconsin:
By V. Webster Johnson 138

Book Reviews and Abstracts:
By Phoebe O'Neall Faris 144

For Reference:
Compiled by Mrs. Etta G. Rogers ..... Opposite 144

A VEHICLE FOR EROSION CONTROL

SOIL CONSERVATION is issued monthly by SOIL CONSERVATION SERVICE of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. SOIL CONSERVATION seeks to supply to workers and cooperators of the Department of Agriculture engaged in soil conservation activities, information of especial help to them in the performance of their duties, and is issued to them free by law. Others may obtain copies from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of $1.00 per year, domestic; $1.40 per year, foreign. Postage stamps will not be accepted in payment.

WELLINGTON BRINK
EDITOR

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

VOL. III • NO. 5

H. H. BENNETT
Chief, Soil Conservation Service

NOVEMBER • 1937

ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON

Society and the Farmer Have Mutual Interests in the Land

By M. L. Wilson, Under Secretary of Agriculture

I HAVE been asked to tell something of my faith in the soil conservation districts laws as instruments to enable farmers and society to attack the soil erosion problem cooperatively. In my opinion, these laws, which permit farmers to work together and with public agencies to arrest soil blowing and soil washing, are important milestones in the national conservation program.

Nowadays it is generally realized, or perhaps I should say, it is becoming generally realized, that society and the farmer have a mutual interest in the land. It was not always so. In the early days of our history, during the settlement years when there was plenty of free land, this mutual interest in the land and its conservation was fully appreciated by only a few. Not many thought as did Patrick Henry who, early in our Nation's history, said: "He is the greatest patriot who stops the most gullies."

It was only natural during the years of rapid agricultural expansion that little thought should be given to the welfare of the land. During Colonial days no prophet dared to predict that a population of 3 millions of people confined to a narrow shelf of land along the Atlantic shore would swell to 130 millions in 150 years and reach to the Pacific. If there had been such a prophet he would not have been believed. It was natural then to look upon the land supply as being inexhaustible, like the air. It was also natural to look upon one's relationship to the land in a purely personal light. Whether one farmed well or whether one farmed poorly, one hardly felt that society held a stake in the result. It didn't seem to matter a great deal if one farmed poorly and ruined a few acres of good land. There was always more land to the west.

This philosophy, born of plenty, held over long after Colonial times and early settlement days, and did not begin really to undergo great change until the supply of good lands began to dwindle. By the time the public domain was closed to homesteading a few years ago, it had, however, almost disappeared. Meanwhile a new concept of the farmer's and society's interest in the land has appeared and gained acceptance. Put very broadly, this new concept assumes that society has an interest in the privately owned farm which is at least equal to the interest of the owner himself. If this assumption is sound, and I believe that it is, obviously it throws new duties both upon the landowner and society. It becomes the duty of the landowner so to handle his land as to conserve the soil and its fertility in the interest of society, and it becomes the duty of society to assist the landowner to make the best use of his land. Thus the individual landowner and society share the responsibility of preserving our lands for the generations to come. But up to now, our efforts at sharing responsibility have been awkward and ineffectual. Society and the landowner have not been able to enter fully and freely into the partnership which is necessary if the responsibility of each is to be met. The mechanism for doing so has been lacking.

Now, however, a number of States have passed soil conservation districts laws which provide the means for close partnership and cooperation among farmers, ranchers, and society in order to control accelerated

Thorough understanding of what is proposed is a necessary preliminary.

erosion. Elsewhere in this issue of SOIL CONSERVATION Philip Glick describes the provisions of this State legislation. For this information I refer you to his article. I shall confine my remarks to the democratic nature of the processes for which the soil conservation districts legislation provides the mechanism.

The philosophy of democratic government revolves around the principle that the mass of the people is capable of governing. It is my conviction that a democracy, therefore, cannot be said to be succeeding unless the mass of the people participates in the affairs of government. Only their participation makes a democracy work. What I like about the districts legislation is that this principle is uppermost.

The soil-conservation districts laws place the responsibility for the initiative and management of a soil-conservation program upon local folk. To begin with, there is nothing mandatory in the laws about dividing a State into soil-conservation districts. Whether a district is to be formed rests entirely with the people who work the land. They express their decisions by petition and in referenda. They elect a majority of the supervisors, who are the chosen leaders of the district. They develop their own program. They are answerable to no other agency in the conduct of their program. Its reins are held tightly in the hands of local people. Should land-use regulations appear to be necessary, the decision to adopt them rests solely with the local supervisors, who, however, can proceed only with the approval of their neighbors, who again express themselves in a referendum. Should it appear necessary after 5 years to dissolve a district, the decision as to this rests also with local people, who again express themselves in a referendum. Every step in the procedure—in forming a district, in operating it, even in dissolving it—is surrounded by safeguards which assure that the things done in the local soil-conservation program are done only because a large majority of the local folk believe them sound and a benefit to their own and the community welfare.

So long as the work of the district is so firmly held in the hands of local people, as the procedures provided for in the State laws require, we need have little fear that any district will proceed with a program that is not based on common sense and is not generally subscribed to by the land occupiers within the boundaries of the district. I think this is particularly true of the provisions in the laws which permit farmers to draw up and vote land-use regulations upon themselves.

I am not sure that the phrase "land-use regulations" is the best name for this part of the erosion-control program. To some the word "regulations" may imply regimentation, and every paragraph in the various State laws is carefully drafted to avoid all possibility of regimentation. Democratic procedures are required in each step in forming and operating a district. To my ear "community soil-conservation laws" is a better phrase.

"Land-use regulations" really are the ordinances of the district, similar to the ordinances which every city, town, or county may adopt. Everyone is familiar with county weed-eradication laws, with city zoning ordinances, with town building codes, sanitary regulations, and the like. To these we are accustomed and have come to accept them and consider them as evidences of good housekeeping in government. There is nothing unreasonable about community laws for protecting drinking water, for example. Nor is there anything unreasonable about laws for protecting the land.

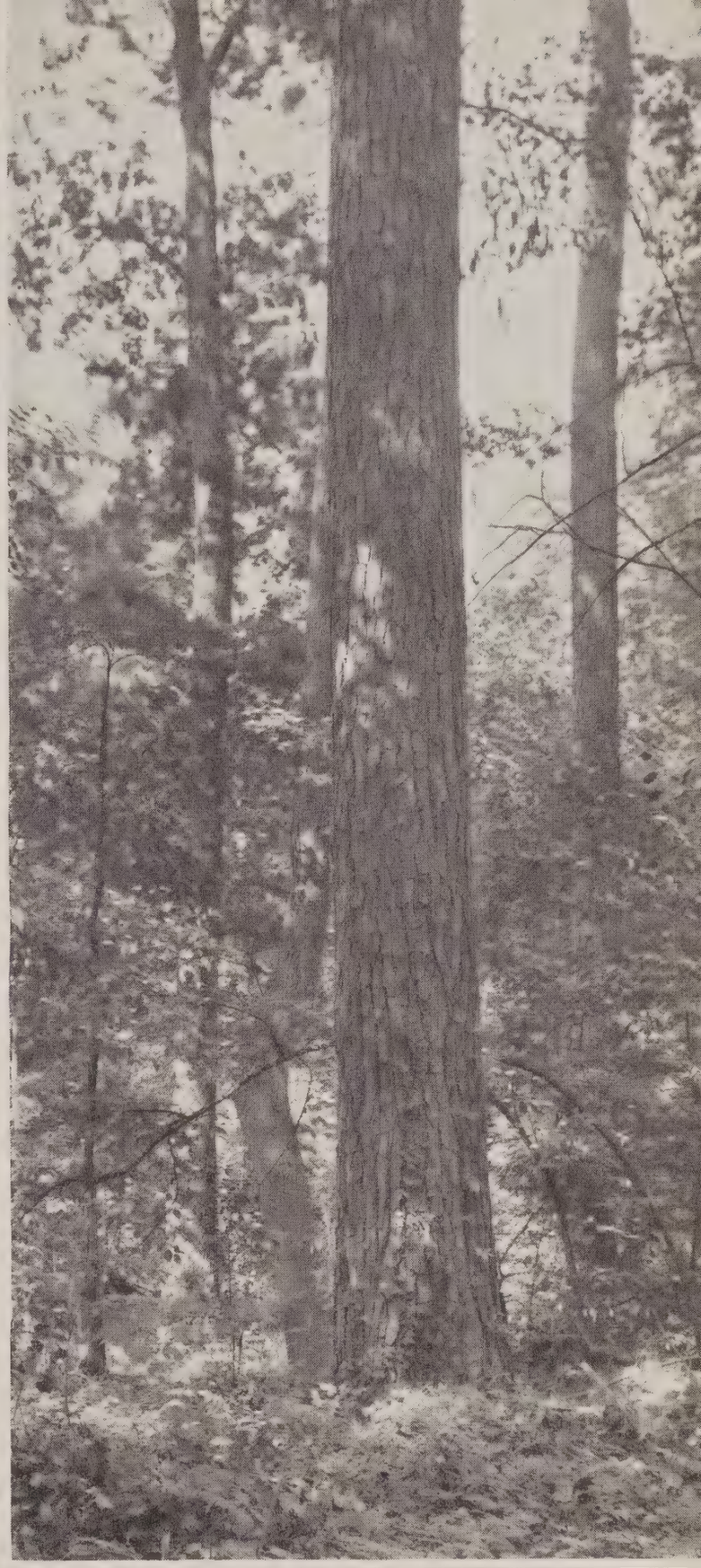
In my opinion, many districts will find it unnecessary to adopt any land-use regulations. You and I, who work with farm people, know that they don't want to see the land abused. The kind of people who live on the land like green fields. They like to harvest good crops. Such folk will be willing, as soon as the mechanism is provided, to work together and with society's agencies to assure that posterity will inherit green fields and forests rather than eroded hillsides and barren plains. But in many cases, reasonable land-use regulations may be needed to assure the adoption of essential measures to prevent the soil from washing and blowing away.

The American economy of today is maturing. Particularly is this true of agriculture. The pioneer stage of our development has made way for a second stage, one in which change among the elements occurs at relatively slower rates of speed, and in which greater stability for agriculture and greater stability among all of the members of the economic structure are regarded on all sides as desirable. The passage of soil conservation districts laws by 22 States since January 1, 1937, is strong evidence that the nature of the change is now popularly realized.

Into our present stage of agricultural history, the districts plan fits very neatly. The districts legislation in every paragraph recognizes that a change has occurred from a pioneer to a maturing economy. It offers a means of effecting land stability, of supporting the very foundation upon which our farming communities rest, and thus helps to stabilize society as a whole.

During the transition period to a mature economy, many adjustments must be made. We must discard many of the old points of view which led to an agricultural economy which has proved to be in discord with Nature, as abandoned farms, accelerated floods and dust storms testify. To realize that we must learn to work and live in harmony with Nature, and play the farming game according to Nature's rules, is in itself a long step forward.

(Continued on p. 143)



This noble pine symbolizes the dignity of intelligent land use.

State Legislation for Erosion Control

By Philip M. Glick[1]

WHEN the Congress provided by law for the national erosion-control program of the Soil Conservation Service it recognized that the program of the Service cannot, by itself, solve the serious erosion problem. Section 3 of the Federal statute, as approved April 27, 1935, therefore authorized the Secretary of Agriculture to require the enactment of suitable supplementary State legislation as a condition to the expenditure of Federal funds for erosion-control operations in any State. It may be well to quote the relevant part of section 3 at this point. It is as follows:

> SEC. 3. As a condition to the extending of any benefits under this act to any lands not owned or controlled by the United States or any of its agencies, the Secretary of Agriculture may, insofar as he may deem necessary for the purposes of this act, require (1) the enactment and reasonable safeguards, for the enforcement of State and local laws imposing suitable permanent restrictions on the use of such lands and otherwise providing for the prevention of soil erosion; . . .

The need for State legislation in this field arises out of the fact that the problem of erosion cannot be adequately solved by work in widely separated areas. Unless State legislation provides a mechanism by which farmers can organize themselves for cooperative action, to apply on their lands the erosion-control practices observed on the demonstration projects of the Soil Conservation Service, the full benefits of the Federal program cannot be realized. In a word, State legislation is needed to assure permanent results from the expenditure of Federal funds.

The Department of Agriculture has worked with representatives from a large number of States in preparing a standard statute which has come to be known as "The Standard State Soil Conservation Districts Law." In February 1935, the President of the United States wrote to the 48 State governors, urging them to recommend to their respective State legislatures the adoption of legislation along the lines of the Standard Act. At the recent sessions of State legislatures, 22 States adopted legislation more or less along the lines of that Act.

It is the purpose of this article to state the basic provisions of the Standard Act and of the legislation modeled upon it and now in force in 22 States.

Section 2 of the Standard Act contains a list of legislative determinations and a declaration of legislative policy. This section was drawn on the assumption that, despite all the discussion in recent years of the seriousness of the erosion problem, the basic facts are still too little known. In addition, it seeks to bring together these basic considerations in the statute, so that they may be readily available for the consideration of the legislatures deliberating on the bill and the courts who will be required to pass upon its constitutionality. Section 2 therefore recites that the consequences of soil erosion in the form of soil blowing and soil washing are as follows:

1. Silting and sedimentation of stream channels, reservoirs, dams, ditches, and harbors.
2. Loss of fertile soil material in dust storms.
3. Piling up of soil on lower slopes, and its deposit over alluvial plains.
4. Reduction in productivity or outright ruin of rich bottom lands by overwash of poor subsoil material, sand, and gravel swept out of the hills.
5. Deterioration of soil and its fertility, deterioration of crops grown thereon, and declining acre yields despite development of scientific processes for increasing such yields.
6. Loss of soil and water which causes destruction of food and cover for wildlife.
7. Blowing and washing of soil into streams which silts over spawning beds, and destroys water plants, diminishing the food supply of fish.
8. Diminishing of the underground water reserve, which causes water shortage, intensifies periods of drought, and causes crop failures.
9. Increase in the speed and volume of rainfall run-off, causing severe and increasing floods, which bring suffering, disease, and death.
10. Impoverishment of families attempting to farm eroding and and eroded lands.
11. Damage to roads, highways, railways, farm buildings, and other property from floods and dust storms.
12. Losses in navigation, hydroelectric power, municipal water supply, irrigation developments, farming, and grazing.

Section 2 then adds that past experience and research have demonstrated that if soil resources are to be conserved and soil erosion is to be controlled and prevented, the following are among the corrective methods which should be adopted:

1. Carrying on engineering operations such as the construction of terraces, terrace outlets, check dams, dikes, ponds, ditches, etc.
2. Utilizing strip cropping, lister furrowing, contour cultivating, contour furrowing and land irrigation.
3. Seeding and planting of waste, sloping, abandoned, or eroded lands to water-conserving and erosion-preventing plants, trees, and grasses.

[1] Chief, Land Policy Division, Office of the Solicitor, U. S. Department of Agriculture, Washington, D. C.

Terracing associations have proved the value of working together for soil conservation.

4. Forestation, reforestation, suitable crop rotation, retardation of run-off, and soil stabilization with trees, grasses, legumes, and other thick-growing, soil-holding crops.
5. Retirement from cultivation of steep, highly erosible areas and areas now badly gullied or otherwise eroded, to grass or trees.

What the Standard Act Provides

The Act provides, in essence, a procedure by which soil conservation districts may be organized—such districts to be governmental subdivisions of the State—to exercise two types of powers:

1. The power to establish and administer erosion-control projects and preventive measures, including assistance to farmers in controlling erosion on their lands.
2. The power to prescribe land-use regulations in the interest of the prevention and control of erosion, such regulations to be first submitted to local referendum and, if approved in the referendum, to have the force of law within the district.

The State Committee

The Act establishes a "State Soil-Conservation Committee" which has power to define the boundaries of each district, to encourage the organization of districts, to bring about an exchange of information and experience among the districts in the State, and to coordinate the several district programs "so far as this may be done by advice and consultation." Each district is an independent unit, and is not subject to the control of the State committee. The Act provides that the State committee shall have not less than three nor more than five members, and that the following shall be its members: The State director of extension, the director of the State experiment station, and the State conservation commissioner or commissioner of agriculture, if there are such officers in the State. The committee is authorized to invite the Secretary of Agriculture of the United States to appoint one person to serve as a member of the committee.

How Districts are Organized

The procedure of organizing districts is as follows: Any 25 land occupiers may petition the State committee to establish a district. The act defines "land occupier" to include any person or corporation who holds title to or is in possession of lands, either as owner, lessee, renter, tenant, or otherwise. The committee is required to hold a public hearing on the petition, to define the boundaries of the proposed district, and then to submit to all land occupiers living within the boundaries defined the question as to whether or not the district should be created. No district may be established unless a majority of the votes cast in the referendum is in favor of such creation.

The District Supervisors

Each district is to be governed by a group of five supervisors, two of whom are to be appointed by the

committee, and three to be elected by the land occupiers of the district. Each supervisor, whether elected or appointed, holds office for 3 years. The supervisors are to receive no compensation other than expenses necessarily incurred. A paid staff may be provided for each district.

What the Districts May Do

When organized, each district will have power to perform research experiments in erosion control; to conduct demonstrational projects; to carry out preventive and control measures; to enter into contracts with farmers and give them financial and other assistance; to buy lands for retirement or for project purposes; to make loans and gifts of equipment, machinery, seeds, etc., to farmers; to take over and operate State and Federal erosion-control projects; and to recommend land-use plans for soil conservation. These powers can be carried out upon private lands only with the consent of the owner.

Land-Use Regulations Binding on All Lands

In addition to the above listed powers, the supervisors of each district may formulate an ordinance prescribing land-use regulations for soil conservation. Such regulations cannot go into effect, however, until after they have been submitted to a referendum of the land occupiers and have been approved in such referendum by a majority of the votes cast. The regulations may be amended or repealed, but only after such amendment or repeal has again been submitted to a referendum. These regulations may include provisions requiring engineering operations such as construction of terraces, check dams, etc.; requirements for particular methods of cultivation, such as contour cultivating, lister furrowing, strip cropping, planting of trees and grasses, etc.; specifications of cropping programs and tillage practices, including rotations; and requirements that steep or otherwise highly erosible land be retired from cultivation.

How Regulations are Enforced

Failure by land occupiers to observe the regulations is punishable by fine as a misdemeanor. In addition, the supervisors may file petition with the local courts asking the court to order the land occupier to observe the regulations. Such court order may provide that if the land occupier fails to perform, the supervisors may go upon his lands, do the necessary work, and collect the costs from the land occupier.

Allowing Exceptions to the Regulations

In any district which adopts land-use regulations, the Act requires that a board of adjustment be established. Upon petition of the land occupier, the board of adjustment is authorized to permit variances from the land-use regulations in cases where application of the strict letter of the regulations would result in "great practical difficulties or unnecessary hardship." Decisions of the board of adjustment are subject to review in the local courts.

Districts are authorized to cooperate with one another, and all agencies of the State are directed to observe, on lands which they are administering, all applicable land-use regulations.

Discontinuance of Districts

After a district has been in existence for 5 years, land occupiers may petition for discontinuance of the district. The question of discontinuance must be submitted to a referendum after which the district will be wound up unless a majority of the votes cast are in favor of continuance.

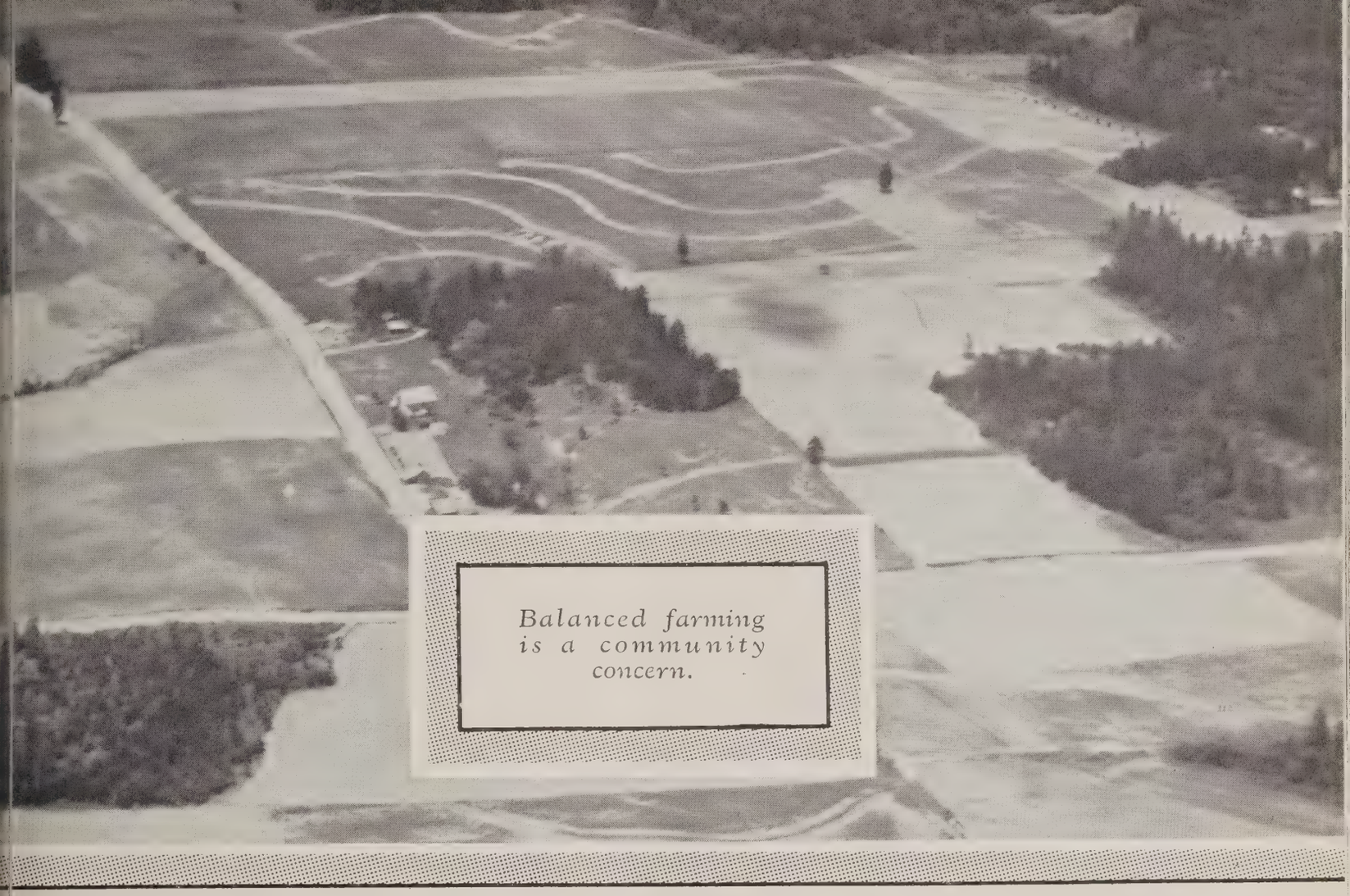
Source of Funds for Districts

The Standard Act provides for an appropriation out of the State treasury to be divided among the districts by the State committee. In addition, it authorizes the districts to accept grants-in-aid from the Soil Conservation Service or other Federal agencies to supplement the State appropriation. The districts are not authorized to levy any taxes or special assessments or to issue bonds.

Basic Considerations Which Influenced the Drafting of the Act

The provisions of the Act are intended to satisfy the following requirements, which are considered fundamental:

1. A genuine attack on the erosion problem requires more than the construction of terraces and dams. Land-use practices and cropping programs must be adjusted in many cases.
2. Practically all the lands in particular watersheds must be brought under uniform control. Arbitrary boundary lines should be ignored and programs formulated over naturally bounded areas.
3. This program can be made effective only if farmers can be induced to cooperate voluntarily. The Act should, therefore, create machinery which the farmers can use when they are convinced that action is desirable. Some machinery should, however, be provided whereby a majority of the farmers may vote land-use regulations upon themselves and thereafter compel a recalcitrant minority to comply where it is for the public good.



4. The farmers must be able to feel that the program is largely in their own hands. The only way to bring about this feeling is to leave the program largely in their hands—hence the provisions for referendums and elections.

5. Because of the wide variance in conditions within a single State, land-use regulations must be formulated locally and must be flexible.

6. Where the results of land treatment increase the public welfare and social good the costs of the operations should not be thrown wholly upon the land owners.

It will be seen that the Standard Act will enable farmers in any area voluntarily to organize themselves into a district in order to apply on their lands the practices learned from State and Federal erosion-control demonstration projects. Complete power is reserved to the farmers to determine whether a district shall be organized, to elect a majority of the governing board, and to determine whether land-use regulations shall be adopted, and what such regulations shall provide.

Participation by "Land Occupiers"

It will have been noticed that the Standard Act provides for participation in the signing of petitions and in referenda and elections by all "land occupiers," rather than merely land owners. "Land occupier" is defined in the statute to include all land owners, as well as all those who are in possession of farm lands, as lessee, tenant, renter, or otherwise. This means that when any farm is owned by one man and operated by another, both the owner and the operator participat in all stages of the program under the statute. This provision of the Standard Act springs from recognition of the fact that the understanding participation of all those who will be affected by programs under the Act must be secured. The landowner should, of course, be represented because his is the title to the land and because many of the costs will fall upon him. The lessee, tenant, renter, or other operator must also be represented. The burden of many of the operations, such as maintaining terraces, seeding on the contour, and other day-by-day farming practices all of which must be so carried on that they will not interfere with the control of erosion, will fall upon the man actually operating the farm. It is therefore believed that it would be a serious mistake to limit participation under the statute to landowners and to exclude all other land occupiers.

Recent Action by State Legislatures

Legislation, more or less along the lines of the Standard State Soil-Conservation Districts Law, was adopted during the recent sessions of State legislatures in the following 25 States: Arkansas, Colorado, Florida, Georgia, Illinois, Indiana, Kansas, Maryland, Michigan, Minnesota, Montana, Nebraska, Nevada,

New Jersey, New Mexico, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Carolina, South Dakota, Texas, Utah, and Wisconsin. The Governors of Texas and of Ohio vetoed the statutes in those States. Twenty-three States, therefore, now have legislation providing for erosion control in one form or another.

The statute adopted in Montana is sketchy, ambiguous, and unsatisfactory, and it is doubtful that much, if any, progress can be made under the present law. Interested people in Montana are considering submitting to the next State legislature amendments to bring the Montana law in line with the Standard Act. Minnesota and Nebraska have not made adequate provision for enforcement of land-use regulations, having omitted entirely the Standard Act procedure whereby district supervisors are able to go upon the land, perform the work, and collect the costs from the owner. Arkansas, Kansas, Minnesota, Nebraska, New Jersey, North Carolina, North Dakota, South Carolina, South Dakota, and Wisconsin have required more than a majority vote for approval of land-use regulations in the referendum. A two-thirds vote has been required by most of those States, Nebraska and New Jersey requiring a three-fourths vote, Minnesota a vote of 85 percent of the land occupiers, and Kansas 90 percent. It is doubtful whether a provision requiring approval by 85 percent or 90 percent of the votes cast can be considered workable. Colorado is the only State which has abandoned the recommendation of the Standard Act on methods of financing operation of the districts by authorizing the districts to levy special assessments against the lands.

The 22 statutes (excluding Montana) now in force differ from the Standard Act in particulars other than those summarized above. It may be stated in general summary that the statutes now in force should be adequate for comprehensive erosion-control programs to be instituted in all but 5 or 6 of the States which have adopted legislation at the last sessions. At future legislative sessions in these latter States, the statutes may be amended. Similar legislation will be considered at future sessions of States which have not yet adopted such an act. There are indications that the campaign to have adequate erosion-control legislation adopted in each of the 48 States will go on.

What a Typical District Will Be Like

Assume that the statute has been adopted in your State. How would farmers go about organizing a district, and what would such a district be like after it was organized?

First of all, nothing will be done until 25 land occupiers present a petition to the State committee asking it to organize a district. When such a petition has been presented, the State committee will hold a public hearing on the question and consider whether or not a district should be established and what should be its boundaries. If the committee decides that a district is needed, it will define the boundaries and give notice of a referendum to be held on the question of creation of the district. In the referendum all land occupiers may vote. If a majority vote against creation of the district, that ends the matter. If a majority vote in favor of creation of the district, the committee will appoint two supervisors for the district. The two supervisors will file an application for a charter with the Secretary of State. On issuance of the charter, the district comes into being.

There is then held an election in which the land occupiers will elect three more supervisors. The group of five supervisors will then make a study of the district and formulate a program of erosion-control projects and preventive measures. Erosion-control work may be done upon private lands only with consent of the land occupier, and upon public lands only under a cooperative agreement with the agency administering the lands. Funds to finance the projects will have been appropriated from the State treasury and may be supplemented by Federal grants-in-aid.

If the supervisors consider it desirable, they can formulate land-use regulations in the interest of erosion control. They will then have to hold a general referendum on the regulations. If a majority of the land occupiers voting in the referendum vote against the regulations, none can go into effect. If a majority approve the regulations, then they can be enacted into law. The regulations may require terracing, contour furrowing, strip cropping, and similar measures.

If a particular land occupier refuses to control erosion on his land in accordance with the regulations, and his lands are so situated that his refusal interferes with the control of erosion on other lands in the district, then the supervisors may file a petition with the local court asking the court to require that land occupier to live up to the regulations. The court may order him to perform and may authorize the supervisors to go upon his lands and do the work at his expense if he fails to obey the court order.

Sane pasture management will be encouraged under soil conservation districts.

If any land occupier feels that his lands are peculiarly situated so that unnecessary hardships result from applying the regulations to his lands, he may petition the Board of Adjustment to authorize a variance. From the action of the Board of Adjustment an appeal can be taken to the local courts.

After the district has been in existence for 5 years, land occupiers may petition the State committee to wind up the district. The question of continuance must be submitted to a referendum and the district may not be continued in existence unless a majority vote is cast in favor of continuing it.

Is the Standard Act Constitutional?

This is not the appropriate place for a discussion of the constitutional issues which may be raised to test the validity of State legislation of this type under the Federal and State constitutions. Readers interested in these problems, however, may note that the Solicitor for the Department of Agriculture issued an opinion to the Secretary of Agriculture on February 26, 1936, discussing these constitutional issues. That opinion is printed in full in the pamphlet issued by the Department containing the text of the Standard Act. The pamphlet is entitled "A Standard State Soil Conservation Districts Law."

The statutes adopted in 22 States are still too recent for a judgment as to action under the law. The various State committees are getting organized and are holding hearings and conducting referenda on petitions for organizing soil-conservation districts. The success of the program under these laws will depend, to no small extent, upon the capacity and the enthusiasm with which the respective State committees and district supervisors attack their problems.

23281—37——2

The Next Step: Emphasis Shifts to the Districts Plan

By Dillon S. Myer[1]

THIS year's action by the legislatures of 22 States in passing soil-conservation districts laws, patterned after the Standard Act recommended by the Department of Agriculture, is deeply significant to the Soil Conservation Service; first, because it opens the way for a greatly enlarged, and at the same time more intensive, national program of soil defense and, second, because it raises immediate questions concerning the work of the Service in relation to the expanded program.

The questions that are foremost, and which can be answered now, concern the part which the present demonstration program of the Service is to play in the broadened attack; and the form which Service participation will take as the national program enters the districts phase.

Up to the present time, activities of the Service have been confined for the most part to the introduction and application, in cooperation with individual farmers, of practical soil-conserving measures and practices to the lands within relatively small watershed demonstration areas. The watershed demonstration areas have played, and will continue to play for a number of years to come, a fundamental part in the development of a national program.

The demonstration program, however, has been only the first step in a large national program of soil and water conservation. Its purpose has been to introduce conservation measures and practices applicable to a large natural land-use region to a small area that represents as nearly as possible a "cross section" of the region, where they can be tested under actual operating conditions and studied in the light of their possible usefulness to the larger area.

Obviously, the demonstration program does not attempt to solve the problem of the region, it seeks only to point the way toward possible solution.

From the standpoint of national adequacy, effective soil conservation requires the intensive and coordinate treatment of all lands in every natural region of similar soil, slope, climatic, and type of farming characteristics, in accordance with their needs and adaptabilities. This cannot be achieved, naturally, by the intensive application of conservation measures to the lands of a small group of farmers within boundaries of demonstration projects and camp areas. It requires the effective cooperation of many farmers, State institutions, and Federal agencies.

Consequently, as rapidly as soil conservation districts are formed in the various States, the Service, in cooperation with the State committees, will place primary emphasis upon the principle of cooperation with large groups of farmers legally organized under State law, whose holdings and operations represent all land within a complete watershed or natural land-use area, and who are cooperatively engaged in the prevention of soil wastage on a large scale.

This does not mean that the demonstration program is to be abandoned, or that the principle of demonstration is to be ignored as the Service prepares to assist districts. The projects and camp areas already in operation, and individual demonstration farms established in cooperation with the Extension Service, together with a few new demonstration units to be established in the future, will become increasingly necessary to provide a background of substantial experience in planning and applying control measures within the districts, and to serve as proving grounds where measures and practices can be applied and studied under conditions peculiar to each natural area.

In accordance with the policy of the Department of Agriculture, new watershed demonstration projects are being established at present only in those States that have passed adequate soil-conservation district laws. Exceptions to this policy are found, of course, in those States in which the legislatures have not had an opportunity to consider such legislation, and in those States in which the Service has not previously established watershed demonstration projects.

Where demonstration areas are necessary in the future, to provide proving grounds for proper control measures, they will be established in cooperation with soil-conservation districts organized under State acts. Likewise, the services of C. C. C. camp enrollees working under the technical supervision of the Service will be provided in the future in accordance with this same principle, insofar as feasible.

[1] Chief, Division of Cooperative Relations and Planning, Soil Conservation Service, Washington, D. C.

Peace comes to a land where grass both nurtures the kine and shields the soil.

With respect to the exact manner in which the Service may cooperate with districts, numerous specific questions arise which must necessarily remain unanswered until a background of experience has been acquired. In general, however, the Service is prepared to provide, insofar as available funds and resources permit, the following principal types of assistance:

1. Technical personnel to assist the districts in making necessary conservation surveys, in formulating district soil conservation programs, and in preparing conservation plans for individual farms within the districts. Such personnel will also be available to supervise the adoption of individual farm plans and assist in making necessary revisions and performance checks on the plans being adopted. Transportation, and necessary equipment for the technical staff, together with clerical and other office help to serve the needs of the technical staff may also be supplied.

2. A limited supply of new or uncommon varieties of erosion-resistant plants to be used for purposes of demonstration only.

3. A small amount of funds, where justified and available, but not in excess of a small proportion of the total assistance rendered by the Service. Such funds will be supplied on the basis of the needs of the district, and only when matched by an equal sum provided by the district. Monetary grants of this nature may be used by the districts for securing materials, supplies, equipment, etc., subject to approval by the Service. Under certain conditions, available equipment may be provided instead of funds.

While assistance of the types enumerated may apparently be given to the districts without encountering undue difficulty, it may be well to explain more fully the attitude of the Service toward monetary grants to districts.

In the past, Service contributions to individual farmers in the form of materials, supplies, and labor, have led to certain problems which it is hoped to circumvent in the future. For example, in some cases cooperating farmers have been prone to regard such contributions as inducements and have treated them as such with little regard for the terms under which they were advanced. By centering responsibility for the procurement and distribution of such materials, supplies, and equipment largely in the hands of various districts, it is believed that this difficulty will be overcome in a large measure.

Too, Federal procurement on a large scale necessarily involves important and essential regulations and procedures. A staff adequate to handle requisitions, records of accountability, and other administrative detail, would be both large and costly.

Consequently, it seems that some types of services can be provided on a much sounder basis and at less cost to the Service, through small conditional grants in funds. In all cases, the expenditure of such grants should be restricted to those things which cannot readily be supplied by the districts and which will represent a real contribution to the public welfare.

Service cooperation with districts must be governed in all cases by specific provisions written into a memorandum of agreement, or understanding, between the districts and the Service, under which each district will be required, as a prerequisite to Service cooperation and assistance, to provide all materials, equipment, supplies, office and warehouse space, and labor, essential to the development of a sound program but not furnished by the Service or other agencies.

Until the Service has determined by experience the wisest manner in which cooperation may be extended to the districts, Service obligations under each memorandum of agreement, or understanding, necessarily will be subject to certain restrictions. It seems probable that such agreements will need considerable modification and revision after a period of time, and of course, from year to year, contingent upon the action of Congress. This fact, necessarily, will have to be fully understood by the districts before Service cooperation can take tangible form.

The foregoing serves to outline in a general way the kinds of active assistance which the Service is prepared to give to districts. However, before tangible aid of any kind can be extended, the various districts must first request such assistance, and be adequately prepared to utilize it to best advantage when advanced.

The districts have the power to enact and enforce local land-use regulations if such action appears necessary. Ordinances relating to land use may be presented by the supervisors, but must be voted upon favorably by the people before they can be enacted.

In the early stages of development, it seems desirable from a soil conservation viewpoint that efforts be first directed toward the organization and development of a sound operations program in the districts on a voluntary basis. Moreover, in many instances insufficient information and knowledge are available to assist the districts in formulating adequate regulations, and consequently such regulations in the early stages of development would likely be of questionable standard from which later deviation might be difficult. There may, and probably will be exceptions, where regulations are needed and enacted soon after a district is organized. In general, however, land-use regulations will be new to most farmers and probably should be developed by them as the need becomes evident, rather than abruptly.

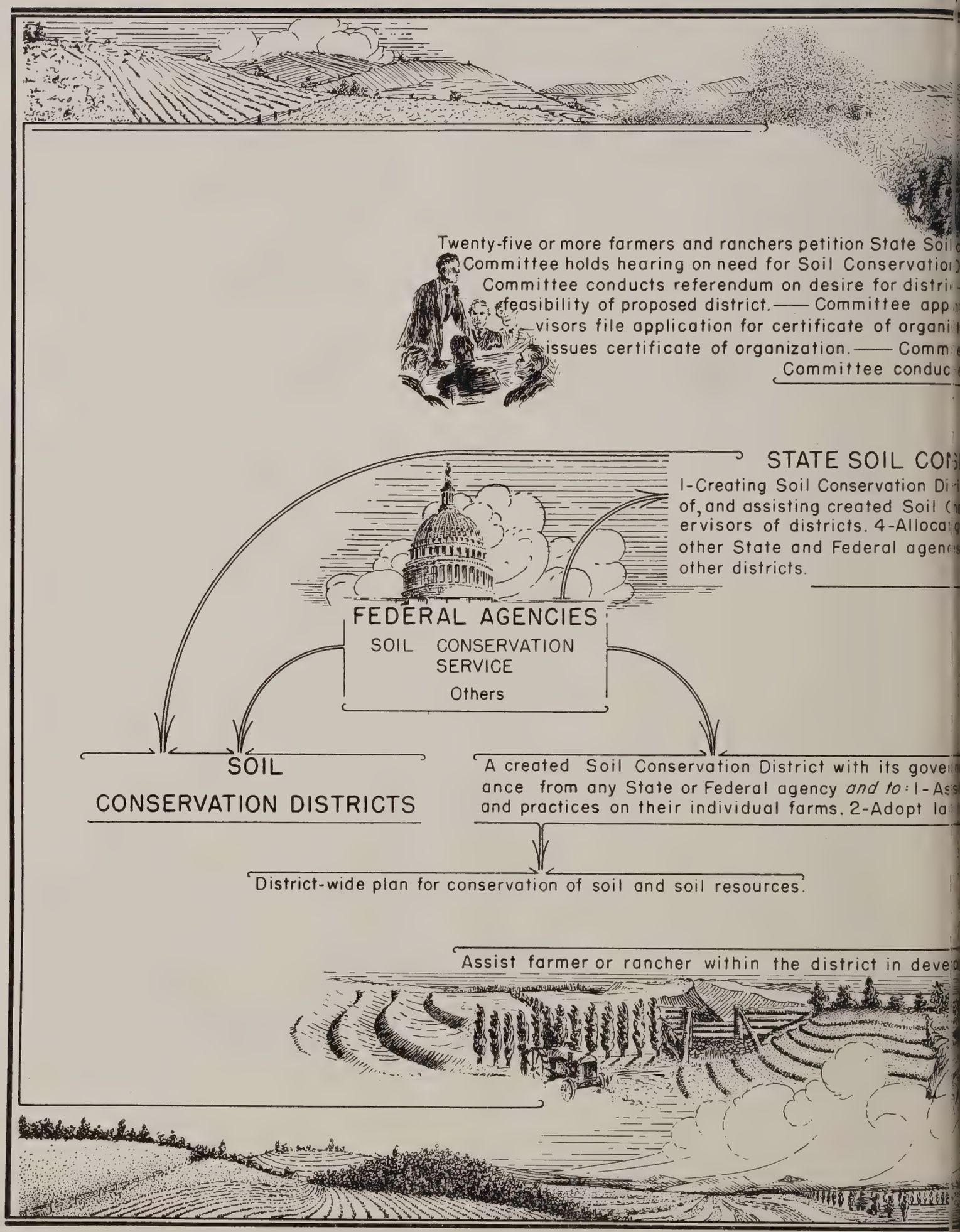
In addition to active operations assistance, the research division of the Service, working in close cooperation with the Agricultural Experiment Stations and other bureaus of the Department, will doubtless be of valuable assistance to the soil conservation districts by continually testing erosion-control measures and developing new conservation methods and practices. An adequate program of research is essential to the proper development of a national soil-and-water conservation program and must be maintained to provide a sound foundation for the individual district programs.

Current developments in this field, together with services of an educational and informative nature, will be made available to the districts through close cooperation with the Agricultural Extension Service.

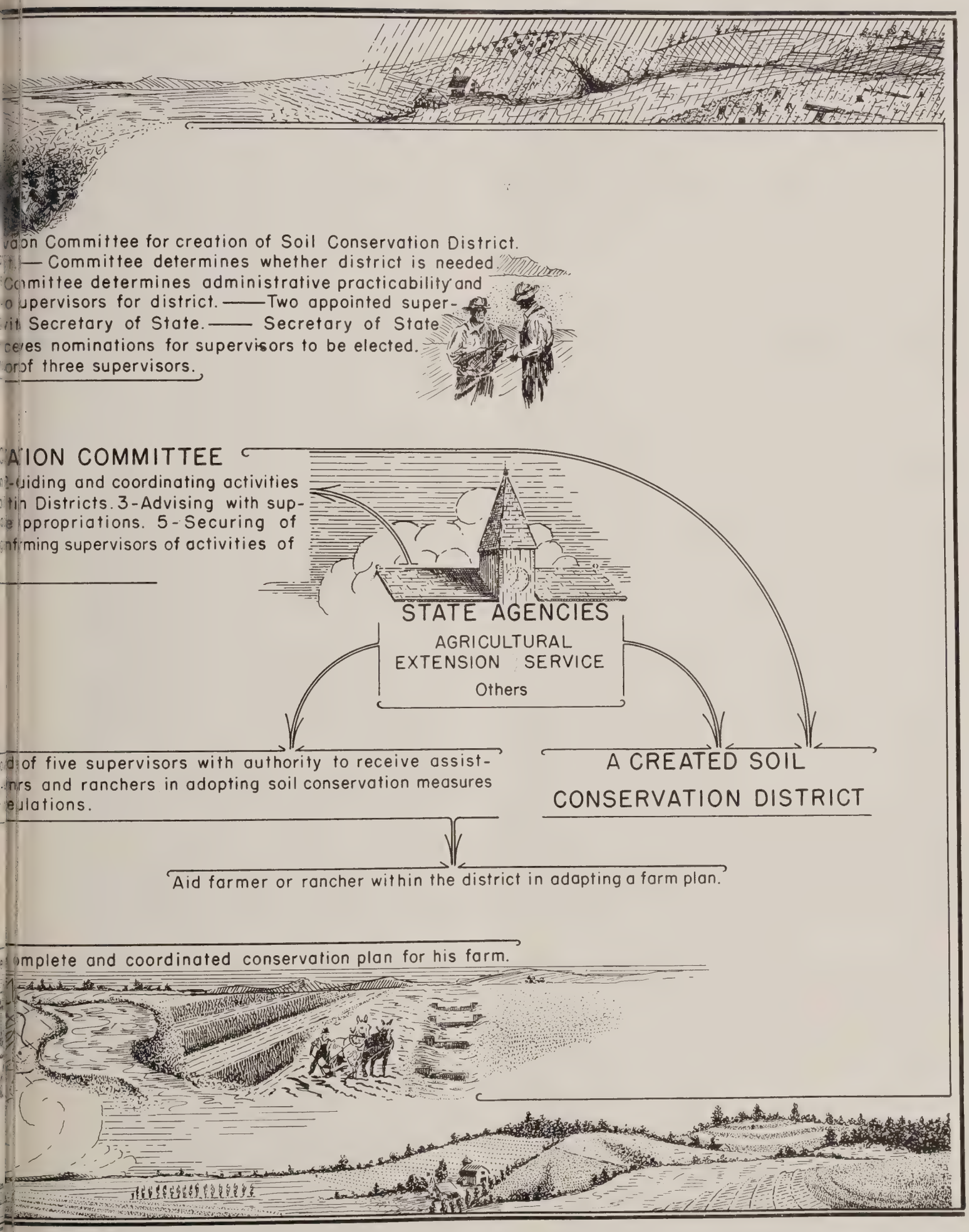
In the final analysis, soil-conserving measures and practices, when applied where needed to the lands of private individuals, result in eventual benefit both to the general public and to the private landowner or operator. The Federal Government cannot be expected to bear an unjustifiable percentage of the cost of erosion-control work on private lands. Yet, when such work is necessary in the interests of the general welfare, it is incumbent upon the Government to provide active leadership and sufficient assistance to get the work done.

Soil conservation districts, vested with legal responsibility, and the power and ability to exercise a thoroughly democratic control over local land use in the interest of the community as a whole, apparently represent an admirable mechanism through which the individual farmer, the States, and the Federal Government, can cooperate on a basis equitable to all.

Nature sets an example in worthy soil stewardship.



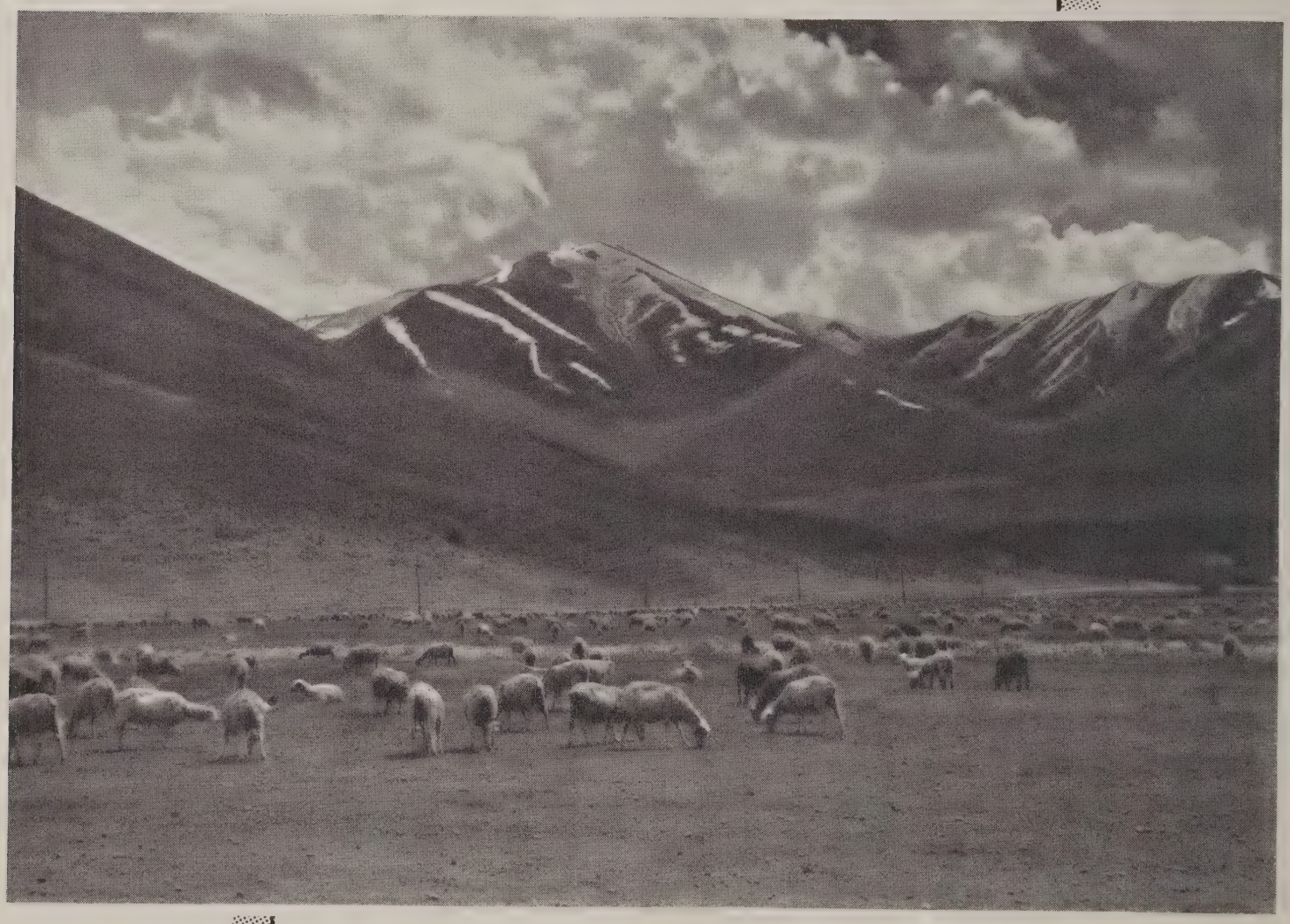
A VEHICLE FOR EROSION CONTROL



A VEHICLE FOR EROSION CONTROL

Associations Lay Groundwork for Legally-Constituted Districts

By J. Phil Campbell [1]



THE Report on Soil Conservation Work by the interbureau committee, approved June 6, 1935, by the Secretary of Agriculture, set forth the following recommendation:

On and after July 1, 1937 . . . all erosion control work on private lands . . . be undertaken by the Soil Conservation Service only through legally constituted soil conservation associations or governmental agencies . . .

Prior to July 1, 1937, new ECW erosion control projects on private lands outside of demonstration areas if not handled through legally constituted soil-conservation associations be undertaken only through voluntary soil-conservation associations . . .

[1] In Charge, Section of Cooperative Relations and Extension, Soil Conservation Service, Washington, D. C.

The committee further stated that—

> We believe the Federal Government cannot manage erosion-control operations effectively with hundreds of thousands of individual farmers, but that local group responsibility will have to be obtained through the organization of cooperative control associations or governmental agencies . . .

Following the committee report, voluntary soil-conservation associations were organized by State Extension Services and the Soil Conservation Service in connection with approximately 500 demonstration projects and ECW camp areas. More than 100 associations were organized outside project and camp areas. Many associations in connection with projects and camps have functioned acceptably and helped to lay the ground-work for legally constituted soil-conservation districts.

Valuable educational work has been carried on in connection with associations regarding practical measures for erosion control which farmers are now putting into operation with the proper technical assistance and guidance. The quality of work accomplished by successful associations has depended to a large degree upon the adoption of a soil-conservation program which delegates definite duties and responsibilities to the board of directors and various committees of the associations.

The leadership and interest shown on the part of the Extension Service, and the cooperation given by the Soil Conservation Service workers have been the main contributing factors to the successful operation of associations. Well-planned educational meetings, tours, field days, and other activities of interest to the membership help to make the educational work of the association worth while.

Many associations have found an opportunity for service by incorporating under State laws for the purpose of handling purchases and for the operation of terracing machinery and lime-grinding equipment for the membership. Some associations outside project and camp areas, where technical services were available, have been very active in supporting the members in the approach to erosion-control operations on their individual farms. Technical advice to individual farmers outside camp and project areas should be directed toward the conducting of demonstration farms in cooperation with members of active soil-conservation associations. The successful operations of active associations are a challenge not only to inactive

associations, but to the Extension Service and the Soil Conservation Service—the organizations responsible for their existence.

The associations that have functioned properly are pointing a way for others. If an effective, coordinated program of soil and water conservation is to be set up, certain definite responsibilities must be assumed not only by individual farmers, but by organized groups of farmers as well.

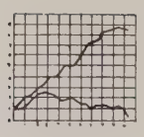
By agreement between the State Extension Service and the Soil Conservation Service, it is a definite responsibility of the farmer to promote the necessary soil-conservation educational work with the assistance, when called upon, of the Soil Conservation Service. The leadership of such a program should rest with the extension soil conservationist or some leader designated by the Extension Service.

The Memorandum of Understanding between the State Extension Services and the Soil Conservation Service provides for the organization of farmers into soil-conservation associations. The active association is the vehicle through which the programs in education and erosion-control operations are conducted within the area served by the association.

Purposes of Association

The main purposes of the association as stated in the Articles of Association are (1) to acquire and disseminate facts and information concerning the character of soil erosion by wind and water, the effects of such erosion including rainfall run-off, floods, reservoir silting, and soil blowing, and the character of the preventive and control measures needed; (2) to promote the cooperation of all residents in the geographical area covered by the association, in a concerted and intelligent effort to prevent and control soil erosion and the wastage of soil and moisture; (3) to bring about widespread adoption of accepted erosion-control and erosion-prevention practices.

The bylaws provide for setting up the necessary committees, one of which is composed of the board of directors of the association and designated representatives of the Soil Conservation Service, the Extension



Service, and other cooperating agencies. This is known as the Local Soil Conservation Committee and develops local land-use policies and principles of local farm management, in accordance with a general State and national program of soil conservation and erosion prevention.

The Committee on Promotion of Membership, Agreements and Cooperation is generally composed of the strongest members of the association. This committee serves to promote a membership among landowners and farm operators in the territory of the association, and particularly seeks their active cooperation in making agreements with the group of supervisors and in giving other aid to the soil-conservation program.

The Committee on Farm Management studies the application of new methods of farm management practices as related to effective erosion control and aids in adapting such practices to local conditions. As an example, this committee studies the application of strip-cropping methods, concerning which a minimum of research data is available and, at the same time, a very large amount of information from practical experi-

ence is to be accumulated through consultation with the local farmers. Pasture management and grazing control are other matters of interest. This committee, through the county agent, is able to secure the assistance of extension specialists in making studies and adjusting plans in the maintenance programs.

In those States where the association is incorporated and operates terracing or lime-grinding equipment, a business committee is appointed to organize cooperative use of equipment, and particularly in connection with the amortization payments. The association president and treasurer should be members of this committee, and the latter should keep all accounts and records, make purchases, collect all funds in connection with the work done, and pay such funds to the proper agencies. If desired, provision is made for legal bond. Likewise, it organizes association activities for the purchasing of lime, seed, and other materials where such are needed in futherance of erosion-control work.

The Forestry Committee is appointed to cooperate with the State Forester, State Extension Forester, and local forestry workers for promotion of sound forest care and use. This refers particularly to organizing work for the protection of woodlands from fire, diseases, insects, grazing, etc., and to cooperative marketing of woodland products, promotion of community forests, and similar concrete activities designed to bring about an integration of forest management practice with farm management.

The Committee on Recreation and Wildlife contacts the proper representatives of the State Conservation Department and cooperates with local sportsmen, hunting clubs, and others, for the promotion of an understanding and interest in wildlife, fish conserva-

tion, and recreation generally. Roadside Planting is furthered by this committee as an aid to attracting tourists and summer visitors, thus adding to the community income as well as to community pride of achievement in successful erosion-control operations.

The Compliance Committee assists in checking cooperator compliance and assists in education of the membership in proper carrying out of the terms of the agreement. Additional committees are formed as needs arise.

Cooperation Between Associations and Districts

Now that 22 States have soil-conservation district laws, the question naturally arises as to the need for local associations of farmers in connection with the districts. Associations in some States have been active in securing the passage of such laws, and in some instances have furnished funds for use by the State soil-conservation committees in the organization of legal

districts. Considering the successful experience of some associations, it is believed that they can render a service to the supervisors of a district. In a district set-up a group of five supervisors constitutes the governing body. This group of five individuals, without salary status and in many cases with no means for reimbursement of expenses, will be limited to making

(Continued on p. 137)

Planned farming supports prosperous villages and towns.

The First District: North Carolina Leads the Way

By I. O. Schaub[1]

AUGUST 4, 1937, constitutes a red letter day in the agricultural history of North Carolina. On that date the Secretary of State issued a certificate setting up the Brown Creek Soil Conservation District as a governmental subdivision. This is the first unit of its kind in the United States.

[1] Director of Extension, State College of Agriculture and Engineering, University of North Carolina, State College Station, Raleigh, N. C.

All the watershed of Brown Creek lying within Anson and Union Counties is included. The district has authority to assist farmers in adopting soil-conservation measures and practices, and the right to prescribe such land-use regulations as may be required to make them effective.

The farm agent of Anson County, J. W. Cameron, was a prime mover in bringing about organization of this district. W. D. Lee, cooperative specialist in soil conservation, assisted the State committee in its creation.

The Brown Creek soil conservation district is essentially a cooperative association of landowners. It is a self-help organization engaging in human as well as material conservation. Since the operation of such a program can be truly effective only when enjoying the whole-hearted support of land operators, each step in the setting up of the district has been by a process of petition and referendum. Control and direction come from the people themselves.

The Brown Creek soil-conservation district was established under an act passed by the 1937 General Assembly, known as the soil conservation districts law. Based upon a standard State soil conservation districts law suggested by the United States Department of Agriculture, the act was enacted to obtain such advantages as might be extended to the State under Public 46 passed by Congress April 27, 1935. Before going to the legislature the proposed bill was studied carefully by the research division of State College. Revised and approved, it was given the sponsorship of a group of interested farm owners and leaders. This group eliminated certain features of the standard act, suggested certain modifications to make it comply with the North Carolina Constitution, and saw the act given legislative approval March 22, 1937.

The soil conservation districts law established a State soil conservation committee, or central board of directors. The committee is composed of the Director of Extension, the Director of Experiment Station, and the State Forester. There is provision also for the appointment of a member by the Secretary of the United States Department of Agriculture. This group charts the State-wide program, assists in setting up districts, coordinates the work of different districts, and disseminates information relative to the program.

Late in May a petition signed by 30 landowners of the Brown Creek area was filed with the State committee, setting forth the need for the establishment of the district and requesting the committee to define the district boundaries.

Acting upon this petition, the committee defined the boundaries and announced a public hearing to determine the need for the proposed district.

Notice of a referendum was published twice in a local paper, as directed by law. Each landowner was notified by mail. Several small meetings were held in or near the proposed district, culminating in a general hearing at Wadesboro, the county seat. A referendum was held. Out of approximately 385 landowners, some 300 voted in favor of establishing the district; there was but one dissenting vote.

Following the referendum, a State committee determined that the operation of the proposed district was "administratively practicable and feasible" and appointed as supervisors W. Henry Liles and R. B. Medley. These men filed application for the certificate of organization of the Brown Creek soil conservation district. This document, as observed at the beginning of this article, was issued by the Secretary of State on August 4.

The next step was the election of three additional supervisors. In keeping with the law, several nominating petitions, each supported by at least 25 signers, were filed with the State committee. A referendum was conducted by mail and the three nominees polling the highest number of votes took office as supervisors along with the two appointees of the State committee. The five supervisors comprise the governing body of the district. In this election all qualified voters were permitted to participate.

The supervisors serve without pay. It is interesting to note that three of them are actual farmers, one is a banker-farmer, and one is a merchant-farmer. Each owns and operates one or more farms.

The supervisors of the Brown Creek soil conservation district has drawn up a plan of operations for cooperating farmers in the area. The entire district program has been presented to various agencies together with a request for technical assistance. The district's plans and procedures contemplate the development of an integrated program through the cooperation of all the agricultural interests of the district, the State, and the Federal Government.

The Brown Creek soil conservation district has led the way. Other petitions have been received by the State soil conservation committee, seeking the establishment of districts along Little Fishing Creek in Halifax and Warren Counties, and along Tar River in Person, Granville, Vance, and Franklin Counties. Farmers living on other watersheds are getting together to discuss what they may do to comply with the recently enacted statute, and to learn of the opportunities which it extends.

A conservation district will leave this ruffed grouse undisturbed on her nest.

Photograph by Alfred O. Gross, Bowdoin College.

Associations Lay Groundwork—*Continued from p. 134*

administrative decisions rather than constructing a virile enterprise. This group will be dependent upon others for the successful operations of the district. The supervisors will, no doubt, call upon active local associations to assist in planning and operating the district programs in their respective communities.

The district supervisors will be responsible under the law for the formulation and development of district-wide plans for conservation of soil resources and for control and prevention of soil erosion.

In addition to the assistance the supervisors may secure from State and Federal agencies, the advice of community or county committees of farmers should be valuable particularly in the formulation of the district-wide plans and plans and operations of local work areas. These committees will be representative of the farmers—if they are selected by the active associations that may exist within the area. Inactive associations should be revived for this purpose. In communities or counties without associations, such committees should be selected by mass meetings of farmers called for that purpose by the county agent.

In addition to the preparation of working plans for the district, the supervisors will, no doubt, desire the assistance of these committees to determine on the location of the first work areas within the district. When such agreements have been reached, it may be desirable for the community committees to organize community erosion-control associations to represent the group of supervisors in the conduct of the work within the selected area. All farmers who join the association would naturally become applicants for farm plans for the control of erosion on their individual farms. The association should keep its books open for additional members as other farmers become interested in the program and are ready to put it into effect. The association should be responsible for naming the farms in the order to be served by soil-conservation technicians who will assist farmers in the formulation and installation of farm plans. All work requests should be routed through the board of directors. Generally speaking they should meet once each month to report to the supervisors on the progress of the work. The local association could become the purchasing and operating agency for the supervisors and the farmers within the community. A federation of associations may be desirable as the work is spread, especially over a large district.

Some of the details of functions of the local associations will be covered in the articles of association, but in the bylaws special provisions should be made to carry out the objectives of the articles of association, and especially to furnish a vehicle for effective cooperation between the members of the association and the district supervisors.

Rural Zoning Improves Land Use In Wisconsin

By V. Webster Johnson [1]

A FORWARD step in land use planning was taken in 1929 when the Wisconsin Legislature amended a strictly urban county zoning enabling law by adding a section which provides:

> That county boards of any county may by ordinance regulate, restrict, and determine the areas within which agriculture, forestry, and recreation may be conducted, the location of roads, schools . . .

Four years later, Oneida County, under the authority granted by this act, enacted the first county zoning ordinance in the United States involving restrictions on the use of rural lands. To date 23 northern and central Wisconsin counties have comprehensive county-wide zoning ordinances in force by which the land is classified into forestry, agricultural, and sometimes recreational use districts. Over 5,000,000 acres of land—much of it subject to serious tax delinquency, scattered settlement, and deterioration of natural resources and most of it cut-over and nonagricultural—have been restricted to further development for agricultural use. Definite progress in changes in agricultural, forest, and recreational uses of land have taken place in the areas zoned in Wisconsin.

Nature of Rural Zoning [2]

Rural zoning provides a democratic means by which local groups of people may exercise reasonable control over the use of their resources in land. It is but a method of applying control by collective action over the use of land and buildings, public or private, in the interest of the general welfare. Such power may be given to a group of people residing within a unit of local government through the police power of a State—that broad grant of power under which government may impose restrictions upon the use of property in protection of the public health and safety, and in promotion of the public welfare. It is difficult to define concepts dealing with social relationships; in this respect, zoning is no exception. Briefly stated, zoning may be considered as the creation by law of districts in which regulations, differing in different districts, prohibit undesirable structures and uses of land, and restrict individual rights in the interest of the public welfare. Of course, the restrictions must be reasonable; the interests of individuals and those of organized government need to be in balance. Private property in land does not include a right to destroy it or to use it in such manner as will injure the interests of the community. Stated positively, the ownership of land includes the right of government to exercise reasonable safeguards in the control of its use.

Forces Leading to Rural Zoning

The need for controlling land use in northern Wisconsin was an outgrowth of the economic and social distress which followed an attempt to develop the area for agricultural use. At one time great hopes were held out for agriculture in northern Wisconsin. The agricultural depression dispelled this illusion. Of course, the whole area is not submarginal agriculturally. There are many well-settled communities enjoying at least a fair degree of prosperity. Scattered throughout the nonagricultural areas are small tracts of land suitable for agricultural use on the basis of their physical characteristics, but in view of their size, location in relation to community centers, and inadequate school and road facilities, these lands are unquestionably better suited to forests and recreation than to agriculture.

Chronic tax delinquency, farm abandonment, high local government costs and increasing need for public relief all followed and accompanied the agricultural recession. The need for some control over settlement and the use of land became apparent to economists, sociologists, foresters, and citizens intimately acquainted with conditions in northern Wisconsin. Basically, the problem was one of achieving conservation of resources and protection of prospective settlers. This is the basic objective of rural zoning in Wisconsin.

Local people are neither inclined nor in a position to get very excited over conservation and the individual

[1] Acting Head, Directional Measures Unit, Farm Security Administration, U. S. Department of Agriculture, Washington, D. C.

[2] To those interested in the type of land-use regulation provided by the Standard State Soil Conservation Districts Law, the question may arise as to the zoning possibilities under this law. From an organizational viewpoint it could be used satisfactorily for zoning. Functionally, under the soil conservation law, cultivation may be prevented on highly erosible land and on land where erosion cannot be controlled by other methods. Control may be by individual tracts, while under a zoning law it is dufficult to conceive how adequate regulations might be applied to scattered tracts. In areas such as found in parts of the Great Plains, it may be necessary to exercise various degrees of control over intermingled tracts. Under such conditions, the soil conservation law is believed better adapted than a rural zoning law. Of course, in order to control the use of large blocks of land, zoning might well be a valuable supplement to a soil conservation district law or a grazing district law. District zoning as carried on in Wisconsin could not be done under the Standard State Soil Conservation District Law.

Water conservation is an important factor in soil conservation.

life of settlers and squatters on private and public lands unless some benefits accrue to them. Rural zoning did not actually get under way because of the need to conserve resources and protect prospective settlers. As Dr. Wehrwein [3] of the University of Wisconsin in a recent article wrote, "The excessive and unnecessary costs of schools, roads, and other public services furnished the trigger that set off the zoning movement in northern Wisconsin. As a result of the rush of settlers into the cut-over areas before the World War and the abandonment of farms after the agricultural depression set in, there were many isolated farms throughout this area. Land companies deliberately placed the first settlers as far from established highways as possible, and then helped the farmer call for a road. There was a law on the statute books that was interpreted to mean that the town was obliged to build a road to any settler who demanded a highway. If other farmers moved into the same vicinity, no harm was done, but if it did not happen the settler was stranded at the end of the road upon which the town had spent $1,000 or more to accommodate a single farmer. Other settlers also chose isolated tracts, but joined the rest in demanding schools, roads, and other public services." The immediate objective of zoning was the control over land as a means of preventing and eventually reducing costs for schools, roads, relief, and other public services.

Forest Crop Law Aids Zoning

Zoning in itself is not a cure-all for all maladjustments in land use. The leaders in Wisconsin did not forget the importance of planning a program of adjustment through the use of other measures or combination of measures, among which, the State forest-crop law, a companion measure to zoning, is of special significance. Under this law, private land used for forest production is taxed at a fixed annual rate of 10 cents an acre for a 50-year period and is then subjected to a yield tax of 10 percent of the value of all timber cut

[3] Wehrwein, G. S. Rural Zoning and Highways. Better Roads. January 1936.

from the forest. For county-owned land (practically all tax-reverted lands) entered under the forest-crop law, the State pays 10 cents an acre to the local units of government.

These provisions tend to induce: (1) Private owners to accept zoning restrictions and restore their lands to forest productions and (2) counties to take tax deed to tax-delinquent land and enter it under the forest-crop law. The forest-crop law to an extent makes the zoning law positive by encouraging an alternative use for land in restricted-use districts. The forest-crop law and the zoning law supplement each other in furthering the use of nonagricultural land. The interest of county and town officials in rural zoning was quickened by the forest-crop law, and possible opposition of individual land owners was lessened by providing favorable ground for an alternate use of their land within restricted-use districts.

Preliminary Work to Rural Zoning

Several years before rural zoning ordinances were enacted in Wisconsin, a number of State agencies conducted county studies dealing with such factors as extent of all industries, maps showing land ownership, soils, operating and abandoned farms, farm communities and primary markets, recreational developments, schools, roads, tax delinquency, and the costs of the various functions of local government by minor

political subdivisions. For instance, during the summer of 1930 studies of this type were conducted in Ashland, Forest, Oneida, and Taylor Counties, and circulars were published shortly thereafter. State agencies contributing to these studies were the Wisconsin College of Agriculture, department of agriculture and markets, geological and natural history survey, conservation department, and the State department of public instruction.

A full knowledge of the agricultural, forestry, and recreational developments, the per capita cost of roads, schools, relief, and other public services as related to definite areas, the physical characteristics and the land-use capabilities of a county are important to an understanding of the need for the ordinance. In brief, it is first necessary to determine the land-use problems to which rural zoning is to apply. In Wisconsin, this work has proved of indispensable value.

Procedure in Enacting Ordinances

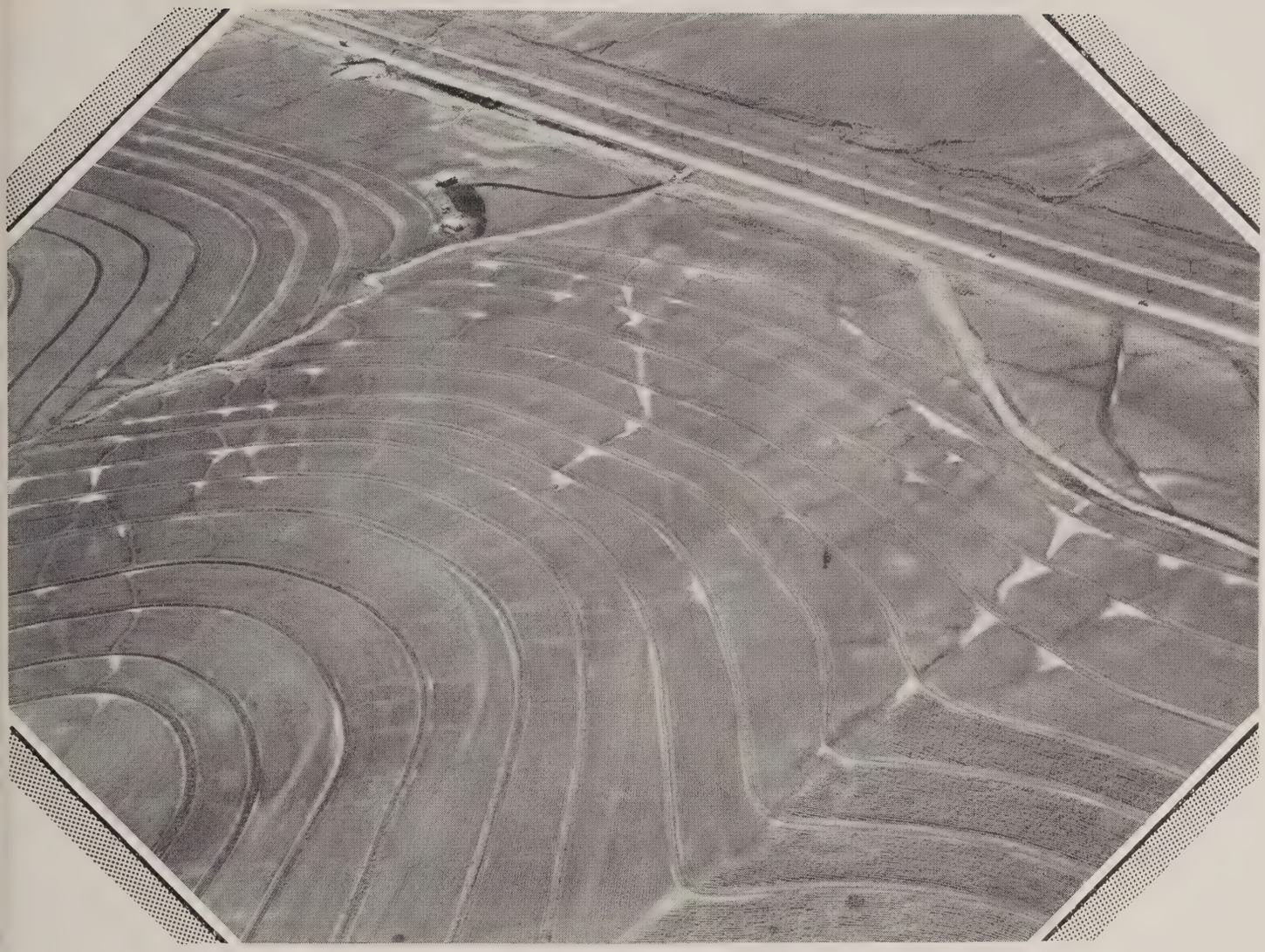
Experience in Wisconsin has established a definite procedure for the enactment of zoning ordinances. W. A. Rowlands and F. B. Trenk [4] of the University of Wisconsin have listed the steps as follows:

1. County board appoints a committee to prepare and sponsor the zoning ordinance.
2. Preparation of a proposed zoning ordinance and map.
3. A series of preliminary meetings held in the towns.
4. County-wide hearings conducted by zoning committee.
5. Ordinance approved by county board and submitted to town boards.
6. Town board approval of ordinance and map.
7. Final enactment of ordinance by county board.
8. Publication of zoning ordinance and map.
9. Preparation of a record of nonconforming uses of land.

Although the general pattern of the zoning ordinance is established by State law, the county zoning committee has by no means a routine task. The county must be divided into two or three types of districts, the uses established in each district, and the exact district boundaries designated on a map. One of the big jobs of the committee is to explain the need for zoning to the people of the county. In Wisconsin, over 200 educational town meetings have been held by the county zoning committees, with the assistance of representatives from the college of agriculture and the conservation department, for the purpose of presenting reasons for proposing a zoning ordinance, the nature of the restrictions contemplated, and a preliminary map showing the areas considered desirable to zone.

The Wisconsin enabling act provides that the zoning committee shall hold public hearings before submitting its final report to the county board, but no mention is made of holding meetings in each town or a county-wide public hearing. By holding numerous town meetings and a county-wide public hearing—largely extra legal—much has been done to secure the support and respect of citizens and taxpayers throughout the zoned counties. The town meetings have been referred to as a "period of deliberation enabling citizens to better understand the purpose and functions of zoning, and provides an opportunity for the zoning committee to gather sufficient information and knowl-

[4] Rowlands, W. A., and Trenk, F. B. Rural Zoning Ordinances in Wisconsin, Extension Service, Wisconsin College of Agriculture, Circular 281, p. 26.



A preview of agriculture's future pattern. Conservation districts will coordinate terracing operations with other needed soil-saving measures.

edge of local sentiment to enable it to make a full report to the county board."[5] After zoning is sold to the people at the public hearings, the legal requirements of enacting an ordinance are merely a matter of form.

Results and Problems

Sufficient time has not elapsed since the establishment of rural zoning in Wisconsin to appraise it adequately as a directional measure or to present fully the problems which it faces. The value of the restrictions placed on land use, and the results of directing land settlement by zoning have not been in operation long enough to show the benefits which one would expect to take place as the years go by. Nevertheless, definite strides are already noticeable.

It is significant that 23 counties have enacted comprehensive rural zoning ordinances, placing under a more productive use over 5,000,000 acres of land by restricting its use to forestry and recreation. This means also that hundreds of families have been prevented from settling on land unsuitable for agriculture. The numerous letters received by county officials from various individuals in regard to the agricultural capabilities of land in restricted areas are striking evidence that without zoning, settlement would have been more haphazard. Zoning has assisted in avoiding the undesirable economic and social conditions usually present in isolated settlements.

Local government costs have been reduced in a number of isolated areas by the prevention of settlement and by the relocation of stranded and isolated settlers. On a large scale, zoning alone cannot be expected to result in an immediate reduction in public

[5] *Ibid.* p. 24.

expenditures. Throughout the areas restricted for year-round settlement, however, it does prevent the increase of school, road, and other costs necessitated by additional scattered settlement. There is no way to determine the financial benefits derived, but some idea of the amount of possible increased costs prevented is shown by the savings resulting from moving settlers from isolated areas. For instance, last year Marinette County, by purchasing the holdings of five settlers residing in a restricted area, was able to close one school. For the school year 1934–35, the school operating cost was $1,861.30. A substantial number of such savings has taken place in northern Wisconsin as a result of relocation of isolated settlers by exchange of county land acquired by tax deed in an agriculture district for land of isolated settlers in a nonagricultural district, or by the outright purchase of their holdings. The State enabling act provides that the county board may exchange land acquired by tax deed for the purpose of promoting the regulation and restriction of agricultural and forest lands.

It has been said that "relocation without rural zoning is a job never done. Rural zoning without relocation is a job half done. Rural zoning followed by relocation will make both a success." Isolated settlers are bound to cause unreasonable expense to the town, county, and the State for schools, roads, public health, and possibly relief costs. Other undesirable economic and social costs are usually present.

Lespedeza sericea waits to help Southern conservation districts control erosion.

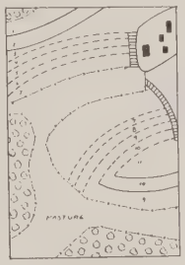
The leaders of the zoning movement in Wisconsin realize the economic and social justification of relocating isolated settlers. The justification is not solely in the interest of land use and human adjustments to make immediately more effective the zoning law; there is also a moral obligation to the settlers and the community because of the restrictions imposed by zoning. The fiscal condition of the county is a bar, in most cases, to the relocation of many settlers by them. In the Federal purchase areas of the Resettlement Administration, the holdings of a considerable number of settlers in restricted areas have been purchased or are in the process of being purchased and their occupants relocated.

During the last session of the legislature a bill was introduced providing for State purchase of lands of isolated settlers in restricted-use districts where a reduction would result in governmental costs of roads,

schools, and other public services. The bill provides for a settler-relocation fund to be ultimately liquidated and supplanted by a fund from savings in State road and school aids. Although there was apparently little opposition to the bill when it passed the House, the Senate did not take it up because of the rush of business during the closing days of the session. It is anticipated that it will be passed by the next session of the legislature.

Administration of Ordinances

The administration of county zoning ordinances in Wisconsin is solely in the hands of the county officials. Each ordinance provides its own procedure for enforcement. This is a real responsibility. That some of the counties are not adequately enforcing the ordinances is a known fact, but most of them are meeting the problem with courage and in a manner to be commended. State and even Federal aid in helping to relocate isolated settlers, it is believed, would do much to strengthen the administration and enforcement of rural zoning ordinances, and thus make them more effective as a means to desirable adjustments in land use and for care and protection of settlers against the undesirable economic and social conditions usually found associated with isolated settlement.



SOCIETY AND THE FARMER

(Continued from p. 119)

Realizing our new hopes will be a long-time proposition, and the chances are they will never be fully realized. Let us look on these hopes as guide posts for the future and bench marks against which we may check progress. As we gain knowledge and experience, the pathway we follow in moving toward our goal will, I am sure, become smoother. The districts legislation, permitting as it does the people of rural areas to gain experience in meeting a common problem in a democratic manner, removes one stumbling block from the path leading to reconstructed farms and a revitalized people. In these two phrases I can sum up all of the philosophy and all of the possibilities which, to me, are contained in the principles underlying the districts legislation.

Regretfully Omitted

Space limitations preclude publication in this issue of several articles of considerable background significance.

As the State soil conservation districts begin to function all over the country, this magazine will endeavor to keep its readers posted.

Regions Pass in Review

The December Soil Conservation will constitute a veritable parade across the country, with each of the 11 regions of the Service represented by one article chosen because of its unique quality, its regional importance, or its wide potential application.

NATURAL RESOURCES OF THE UNITED STATES. By Richard M. Field. New York. 1936.

Dr. Field, who is associate professor of geology at Princeton University, has given us an outline handbook for convenient ready reference. The classification system is interesting in that resources are listed and described from the standpoint of their relationship with science and human activities and needs. The text and pictorial representations (maps, block diagrams, charts, etc.) set forth a large amount of information regarding the United States—physiography and physical geography; hydrology, treating water resources, precipitation and run-off, droughts and floods, irrigation and drainage, waterways and hydroelectric power; lands, with emphasis on soil resources, agricultural and farm lands, forests, grazing and recreational lands; fuels and minerals.

The book is compiled as a handy aid to students of economic geography and conservation, and with the thought in mind that "it is particularly important that the people of the United States should appreciate the natural resources of their country in order that they may determine how best these resources may be developed and conserved."—Phoebe O'Neall Faris.

ADDITIONAL REFERENCES

(Continued from third cover)

Tennessee State Planning Commission. Water Resources of the Cumberland River Drainage Basin—Summary and Comprehensive Report. Apr. 1937. mm. 67pp., illus.

Virginia State Planning Board. Land Use and Agriculture (Sections 1 and 2), Tentative Report. Vol. IV-A of Report of Virginia State Planning Board. May 1, 1937. mm. 137 pp. illus.

Wisconsin State Planning Board. A Conservation and Recreation Plan for Southeastern Wisconsin. Bulletin 3. Dec. 1936. 28 pp., illus.

FOR CONVENIENCE IN SUBSCRIBING TO SOIL CONSERVATION

Superintendent of Documents, Government Printing Office, Washington, D. C.
Enclosed find $1 (foreign, $1.40), for which please enter my subscription to SOIL CONSERVATION for one year.

....
Name (Write plainly) Address

BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

PROFITABLE FARMING AND LIFE MANAGEMENT. By Wilbur J. Fraser. Danville, Ill. 1937

Professor Fraser's book was written specifically for the farmer and might have borne the subtitle "A Balance of Farm Factors and a New Rural Era." Certainly there is a message here for the conservationist as well as for all men and women who seek success and happiness in rural communities. It is more or less definitely a corn belt book; it has the "know thyself" philosophy; and it stresses throughout sincerity and appreciation as the guiding powers of worthwhile and economically successful farming. It makes no pretenses of being a technical treatise on agriculture; but it points out in no uncertain terms the fundamentals or factors of the farming enterprise and the importance of improving limiting factors in order to prevent tremendous waste of natural resources.

Find out your weaknesses and rid yourself of them one by one. This is Professor Fraser's prescription for wise planning on the modern farm. If the low factor is too much land or not enough land, a size of acreage readjustment is imperative. Improper drainage and gully erosion, bare fields and sheet erosion, improper tillage or up- and down-hill cultivation, large herds on small or poor pastures, a cropping system which fails to allow for a continuous supply of plant food elements to all soils, unbalanced feed rations and insufficient or irregular water supply, insanitary housing for stock or storage for forage—these and many other serious defects and faulty farm practices are pointed out and discussed as to their recognition by the farmer as limiting factors to success, and their correction to allow all the fine essentials of production to work together efficiently to increase profit and ensure contentment and well-being.

An interesting and unique feature of the book is the emphasis on grade of individual farmer ability. How can the farmer determine his class? What should determine the size of farm and extent of operations which a farmer should undertake? What happens to the 40-acre farmer on a 400-acre farm? To the 400-acre farmer on a 100-acre farm? To the 400-acre farmer on a 400-acre farm? The third farmer is successful because "he was intelligent, thoughtful and energetic enough to get all his production factors on the same high level as his own ability where they could operate most efficiently in making profitable production."

In a chapter on raising low factors on the individual farm, the author emphasizes the enormous conservation of natural resources that can be brought about on the 5,000,000 farms in the United States when all farmers realize that successful farm management is an obligation as well as a goal.

Interesting also is the part of the book, covering several chapters, which treats the subject of rational consumption and accumulation of capital in order to raise low factors in production and in life. Herein Professor Fraser urges thrift studies in schools. "A man's economic worth equals what he produces minus what he consumes. . . . Irrational consumers steal from society." Practical suggestions for farm thrift are pointed out—care of soils, stock, buidings and machinery, production of the money- and health-saving garden, wise buying, saving and investing.

The final 100 pages of the volume are devoted to a discussion of abundant living on the farm and in rural communities. Education for agriculture as a life work, the farm home, the health factor, community recreation, beauty as an inspiration to success, courage, sincerity and simplicity—all these are stressed as essential factors for a worth-while standard of living on the farm, for the good life.

Under a State soil conservation districts law the farmer actually becomes the arbiter of his own destiny. He and his neighbors for the first time have in their possession an adequate instrument of cooperative erosion control on the watersheds.—Editor.

Snows that will not lead to floods. Conservation districts will provide means for storing this needed moisture for thirsty crops.

U. S. GOVERNMENT PRINTING OFFICE · 1937

National, Regional, and State Studies in Land-Use Planning

For REFERENCE
Compiled by Mrs. ETTA G. ROGERS, Publications Unit

Field offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

National

Basic Provisions of the Standard State Soil Conservation Districts Law. Soil Conservation Service. mm. 11 pp.

Conservancy Districts in Land Management. (A proposed method of meeting a menace to sustained productivity of land.) W. C. Lowdermilk. Soil Erosion Service, U. S. Department of the Interior. Mar. 8, 1934. mm. 4 pp.

Deficiencies in Basic Hydrologic Data: Report of Special Advisory Committee on Standards and Specifications for Hydrologic Data, Water Resources Committee, National Resources Committee. Sept. 1936. 66 pp. 30c (paper cover), Superintendent of Documents, Government Printing Office.

Drainage Policy and Projects: Report of Special Subcommittee, Water Resources Committee, National Resources Committee, on scope and conflicts of Federal activity related to land drainage, and recommendations on practicable means of developing coordinated programs of future work. Feb. 1936. mm. 26 pp.

The Land in Flood Control. A preliminary statement on responsibility of U. S. Department of Agriculture under the Omnibus Flood Control Act of 1936. U. S. Department of Agriculture. Apr. 1937. mm. 36 pp.

A Standard State Soil Conservation Districts Law. Soil Conservation Service. (Prepared at the suggestion of Representatives of a number of States.) 1936. 64 pp. 10c (paper cover), Superintendent of Documents, Government Printing Office.

Studies in Forest Influences and Land Use Planning. W. C. Lowdermilk. Soil Conservation Service. mm. Undated. 9 pp.

Technological Trends and National Policy. National Resources Committee. June 1937. 388 pp. $1.00 (paper cover), Superintendent of Documents, Government Printing Office.

Wildlife and the Land. A Story of Regeneration. 75th Congress, 1st session. 1937. 90 pp.

Regional

Anchoring Farmlands in the Ohio Valley Region. Regional Office, Soil Conservation Service, Dayton, Ohio. 1937. 20 pp.

Basic Data for a Tentative and Preliminary Plan for New England. New England Regional Planning Commission. June 1935. mm. 37 pp., maps, charts, tables.

Better-Balanced Farming for the Oklahoma and Texas Wheat and Grain-Sorghum Area (Including Special Provisions for Wind Erosion Area). Southern Region Leaflet 102. Agricultural Adjustment Administration. 1937. 11 pp.

Proceedings of the Fourth Pacific Northwest Regional Planning Conference. Boise, Idaho, April 8, 9, and 10, 1937. Pacific Northwest Regional Planning Commission. 127 pp.

Report of the First Regional Meeting to Discuss a Regional Survey of Southern Forest Resources. National Resources Committee. Aug. 9, 1937. mm. 6 pp.

Soil and Water: A Discussion of Basic Principles of Soil Conservation in the Southwest Region. Regional Office, Soil Conservation Service, Albuquerque, N. Mex. 1936. mm. 174 pp.

Soil and Water Conservation in the Northern Great Plains. Regional Office, Soil Conservation Service, Rapid City, S. Dak. 1937. 19 pp. 10c. (paper cover), Superintendent of Documents, Government Printing Office.

Soil and Water Conservation in the Pacific Northwest. Soil Conservation Service. U. S. Department of Agriculture Farmers' Bulletin 1773. 1937. 59 pp. 10c. (paper cover), Superintendent of Documents, Government Printing Office.

State

State Planning: Programs and Accomplishments. National Resources Committee. Dec. 1936. 128 pp. 25c (paper cover), Superintendent of Documents, Government Printing Office.

Arizona State Planning Board. Land Use Planning: Water Resources; Flood Control; Power. Vol. II of Report of State Planning Board, December 1936. mm. 359 pp., illus.

Connecticut State Planning Board. Compendium of Studies and Maps. Jan. 1, 1937. Lithographed. 31 pp.

Indiana State Planning Board. County Planning Problems and Their Relative Importance. Jan. 1937. 40 pp., illus.

Iowa State Planning Board. Variability of Cropping Systems and Yields Within the Eastern Meat Producing Area of Iowa (with interpretation of its significance in formation of soil conservation program). In cooperation with the Iowa Agricultural Experiment Station. Nov. 1, 1936. mm. 30 pp., illus.

Iowa State Planning Board. Water Use and Conservation in Iowa: Iowa—Cedar River Basin. Water Resources Committee. July 18, 1936. mm. 133 pp., illus.

Kansas State Planning Board. Need for Conservancy Legislation. Address by Harlan H. Barrows before the Kansas State Legislature. Feb. 12, 1937. mm. 17 pp.

Michigan State Planning Board. Annual Report to Governor Murphy. Dec. 1936. 29 pp.

Minnesota State Planning Board. Report of the State Planning Board. Dec. 1936. 86 pp., illus. Part I: Digest and Interpretations. Part II: Committee Reports—Includes water conservation, metropolitan and urban planning, land use, recommended legislation, planning for the future.

Minnesota State Planning Board. Report of the Water Resources Committee. Jan. 1937. mm. 92 pp.

Montana State Planning Board. Staff Report for Period Ending December 31, 1936. mm. 87 pp., illus.

Nevada State Planning Board. Objectives and Methods of State Planning. Feb. 1937. mm. 15 pp., 13 pp. illus.

New York State Planning Council. Annual Report to Governor Lehman for Period Ending June 30, 1936. 1937. 95 pp., illus.

New York State Planning Council. A Common Sense View of the Flood Problem. Bul. 28. May 1937. mm. 13 pp.

North Dakota State Planning Board. Summary Report of a Plan of Water Conservation for North Dakota. Jan. 1, 1937. Vol. 1: Wild Rice, Sheyenne and Lower Red River. mm. 97 pp., tables, plates. Vol. 2: James River Drainage Basin. mm. 28 pp., tables, plates. Vol. 3: Souris and Devils Lake Drainage Basins. mm. 72 pp., plates, tables. Vol. 4: Missouri River and Minor Tributaries. mm. 48 pp., plates, tables. Vol. 5: Slope Area; Knife, Heart, Cannonball, Grand, Little Missouri, and Yellowstone Rivers. mm. 114 pp., plates, tables.

Oklahoma Planning and Resources Board. Compilation of Laws Pertaining to the Oklahoma Planning and Resources Board. Prepared by Division of State Planning. 1937. mm. 99 pp.

Oregon State Planning Board. Investigation of Land Use in Curry County, Oregon. Report submitted to 39th Legislative Assembly, January 20, 1937. mm. 74 pp., 14 pp. statistics, tables, maps.

Oregon State Planning Board. Water Sources and Watershed Protection Problems of Oregon Municipalities. (Report by staff, submitted by Board to Governor Martin.) Feb. 15, 1937. mm. 26 pp., illus.

Rhode Island State Planning Board. Agriculture in Rhode Island. Special Report 12. June 25, 1937. mm. 75 pp., illus.

Rhode Island State Planning Board. Six Months' Progress Report. January 1 to June 30, 1937. mm. 42 pp.

South Dakota State Planning Board. Artesian Well Flow in South Dakota. Preliminary Report of the Agricultural Resources Committee. Jan. 1937. mm. 138 pp., illus., tables.

South Dakota State Planning Board. Stock Water in Western South Dakota. Preliminary Report. 1937. mm. 18 pp., illus.

South Dakota State Planning Board. Water Resources Committee. Water Resources Reports on Bad River, Big Sioux River, Cheyenne River, Grand River, James River, Keya Paha-Ponca River, Little Missouri River, Minnesota River, Missouri River, Moreau River, Vermillion River, and White River Drainage Basins. 1937. mm.

(See, also, p. 143.)

A COMMUNITY PROTECTS ITS BASIC RESOURCES WHEN FARMERS AND SOCIETY POOL INTERESTS

A DEMOCRATIC PLAN BROUGHT TO THE LAND

LOCAL INITIATIVE TO CONSERVE SOILS

FARM PLANNING SUPPLANTS HAPHAZARD AGRICULTURE

EROSION CONTROL COOPERATION

DOING TOGETHERWHAT FARMERS CANNOT DO SEPARATELY

WHEN FARMERS AND GOVERNMENT JOIN HANDS

CONSERVATION GUIDANCE BY REFERENDUM

S35 Copy 2

OIL CONSERVATION

FICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
ITED STATES DEPARTMENT OF AGRICULTURE · WASHINGTON

U. S. F. S. RECEIVED
LIBRARY
DEC 28 1937

DECEMBER
1937

Contents

Page

Here and There Among the Regions 145

Vermont Takes a Cue from the Dust Bowl:
By C. B. Maits, Jr 146

Water Disposal Plan Required:
By Ralph Fulghum 148

Strip Cropping in Hill Country of Ohio:
By J. S. Cutler 151

Meadow Outlet Strips:
By Harold G. Anthony 153

Buckbrush Check Dams:
By W. W. Russell and L. H. Kahler 155

Stabilizing the Dust Bowl:
By D. A. Dobkins and Virgil S. Beck 157

Soil-Saving Fences:
By Ivy M. Howard 159

Grass and Water Storage on a Quarter-Million-Acre Ranch:
By Kenneth M. Gapen 161

Wide-Row Plantings of Annuals:
By Frank B. Harper 163

Gold in the Grass Roots:
By Harry E. Reddick 165

Straw Farming:
By C. R. Briggs 169

Book Reviews and Abstracts:
By Phoebe O'Neall Faris 170

For Reference:
Compiled by Mrs. Etta G. Rogers ..... Opposite 170

Soil Conservation is issued monthly by Soil Conservation Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. Soil Conservation seeks to supply to workers and cooperators of the Department of Agriculture engaged in soil conservation activities, information of especial help to them in the performance of their duties, and is issued to them free by law. Others may obtain copies from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of $1.00 per year, domestic; $1.40 per year, foreign. Postage stamps will not be accepted in payment.

WELLINGTON BRINK
EDITOR

SOIL CONSERVATION

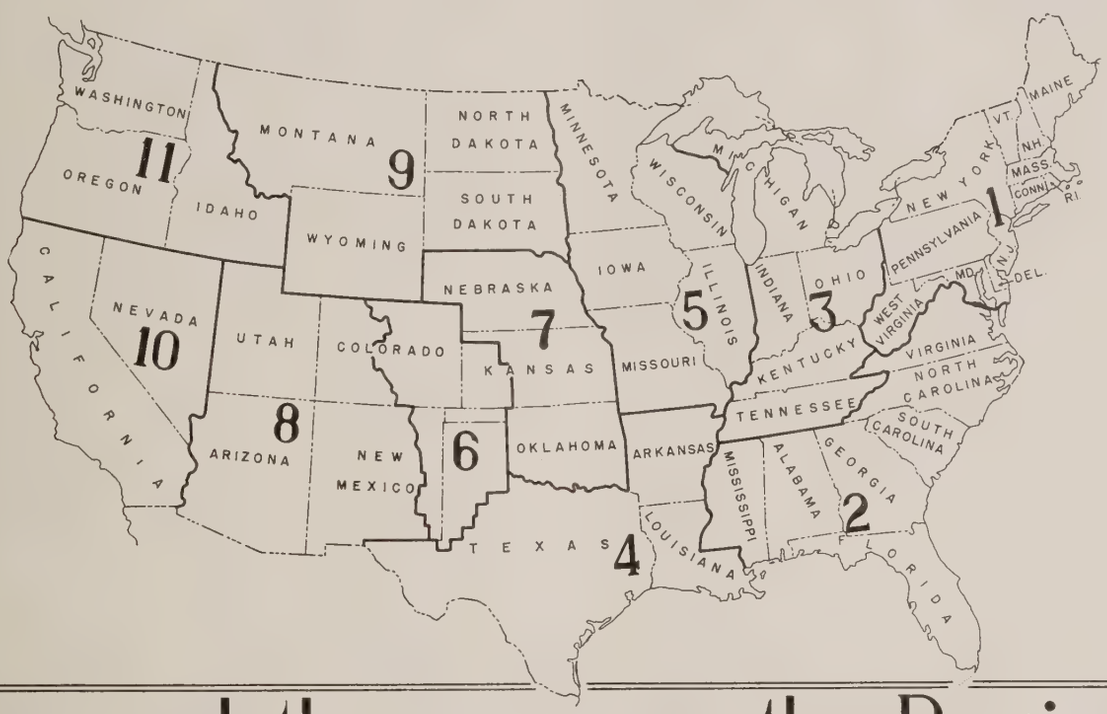
HENRY A. WALLACE
Secretary of Agriculture

H. H. BENNETT
Chief, Soil Conservation Service

VOL. III • NO. 6

DECEMBER • 1937

ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON



Here and there among the Regions

THIS issue is made up entirely of material from the field. Each of the 11 regions is represented.

FEW students of soil conservation may travel extensively among projects, camps, and experiment stations in search of usable ideas or new points of view. Most of us must rely on SOIL CONSERVATION, and other mediums, to do our traveling for us, by proxy.

THIS month the magazine makes a quick round of the regions, from coast to coast, bringing back a varied collection of notes, pictures, maps. Each contribution is included because of some unique quality or because it adds a significant footnote to the growing encyclopedia on soil-erosion problems and their solution.

REGIONS - 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10 - 11

28593—37——1

VERMONT takes a cue from the Dust Bowl

By C. B. Maits, Jr.[1]

ON SANDY soils left by the great ice sheet more than 25,000 years ago, the removal of trees, combined with overgrazing of pastures, has resulted in the formation of small sand blows, ranging from a few feet to almost 20 acres in size. These blows have caused concern for some time among farmers on the Vermont plateaus and steep slopes above the Winooski River.

There are no dust storms in Vermont resulting from creeping sands. Nevertheless, 2,000 miles away from the Great Plains, New England farmers do have a "dust bowl" problem. The blowing sandy wastes are encroaching on their pasturelands—pasturelands that support herds of cattle which are the livelihood of many farmers in one of the country's oldest agricultural communities.

Since deforestation and overgrazing have been the primary and secondary causes respectively of the sand blows, reforestation and controlled grazing are the long-run methods advocated by the Soil Conservation Service to help farmers overcome their wind-erosion problem. For temporary control, many farmers in the Winooski Valley area are resorting to the use of "whisker" terraces and strongly built fences of tree limbs and brush. The "whisker" terraces are merely bundles of brush and limbs staked around the contour of the blows to check further drifting. They are effective on small areas. On larger blows, erosion-control technicians have taken their cue from soil-conservation practices which check water damage in other parts of the Northeastern States. They are using the tree-limb fences to break the sand blows into compartments to minimize the chances of dune formation and smothering of adjacent grassed areas. In other words, just as diversion terraces break up the velocity and volume of water by reducing the size of

[1] Section of Information, Soil Conservation Service, Williamsport, Pa.

"Whisker" terraces are temporarily effective on small areas.

drainage areas, so these fences break up the shifting of sands by cutting down the "blowing" area.

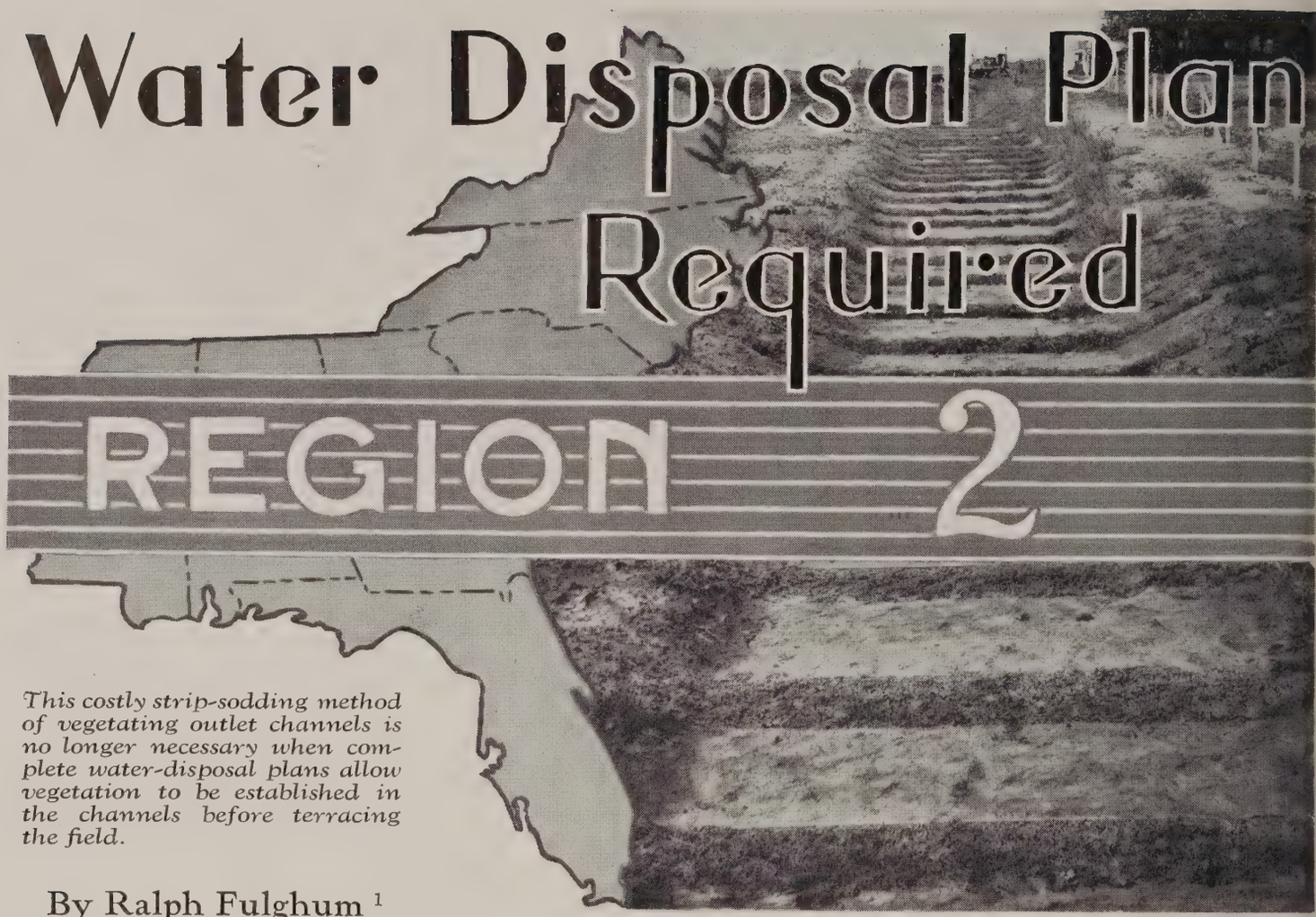
Thousands of pine seedlings are being planted in these tree-fence compartments in the large areas, and between the "whisker" terraces on the smaller areas. Their roots can find a way to productive soil beneath the sandy wastes, and, in years to come, will effect a permanent cure for many a Vermont farmer's midget desert. Fencing is necessary also on both the large and small areas to prevent grazing animals from browsing the seedlings or destroying the structures built for temporary control.

On many of the blows farmers are making effective use of what would otherwise be wasteland by including wildlife plantings in the reforestation process. In the not so distant future, farmer-owners on the hills of the Winooski demonstration area will derive direct benefit from these plantings. The blows will be changed from sterile, creeping wastes to wooded thickets where fur bearers or game birds can find homes and provide a return worth many times the effort expended in halting the miniature but growing menace of wind erosion.

A larger sand blow broken into compartments by tree-branch fences. Pine seedlings, planted at close intervals, will give permanent protection within a few years.

Water Disposal Plan Required

REGION 2



This costly strip-sodding method of vegetating outlet channels is no longer necessary when complete water-disposal plans allow vegetation to be established in the channels before terracing the field.

By Ralph Fulghum [1]

A WATER disposal plan for the entire farm is now required as a part of all new cooperative agreements and all agreements being amended in camp and project areas in Region 2. The ruling became effective November 1 of this year. Such a system was adopted in South Carolina a year ago, and water-disposal plans have been made a part of almost 2,000 cooperative agreements in the State. In its initial stage the system was so successful as to merit its extension to the entire region.

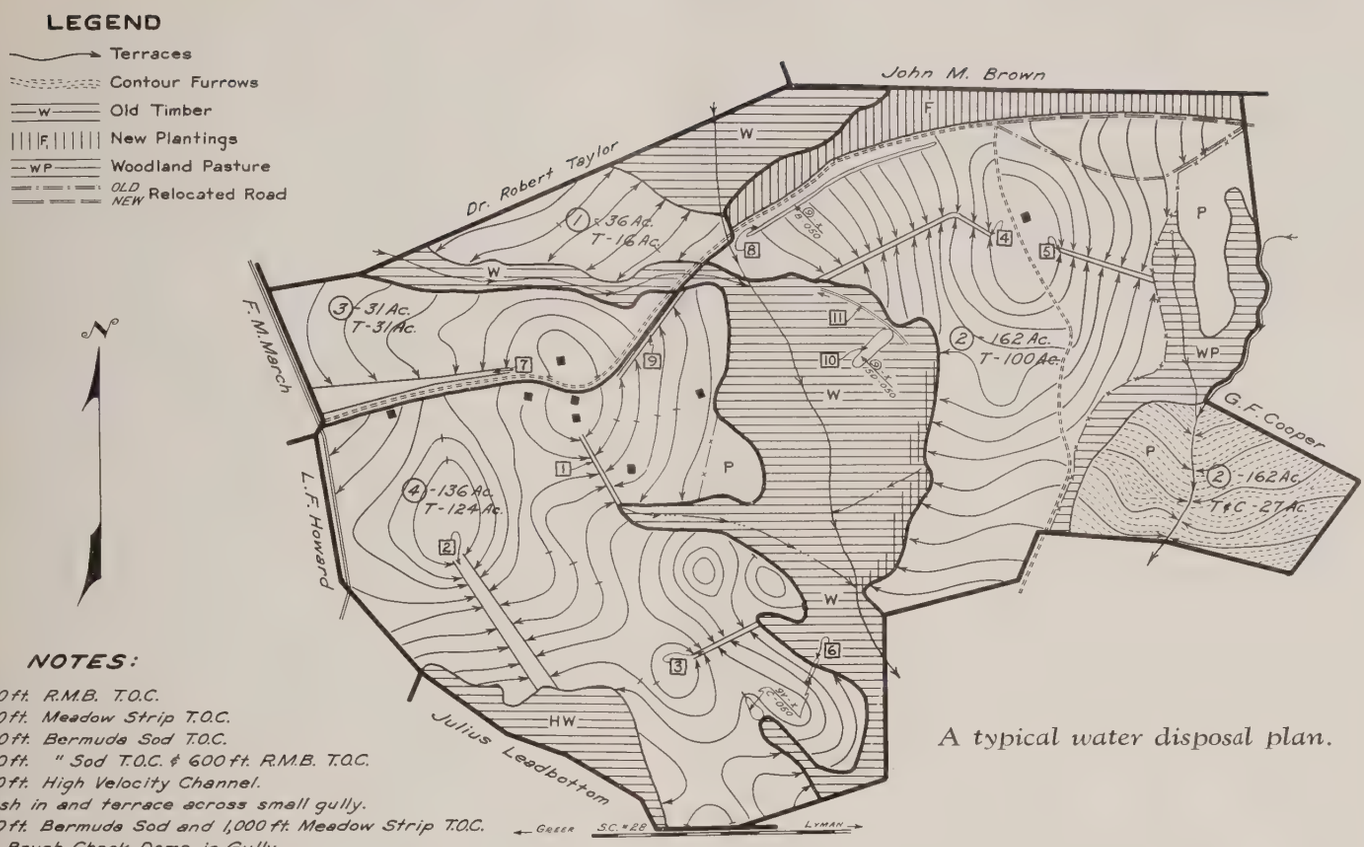
These advanced plans have encouraged the use of vegetation in waterways, have greatly reduced the cost of the practice, and have given the farmer a better understanding of what he needs on his farm. It appears also to be one of the best methods by which the engineer can render technical assistance to large numbers of farmers in organized districts.

Appearing somewhat like a weather map but with the arrows representing terraces instead of pressure areas, the plan for each farm shows where the necessary terraces are to drain, where terrace outlet channels and meadow strips will be needed, wooded areas that should be allowed to thicken before water is turned on to them, gullies to be vegetated before taking water from terraces, necessary relocation of roads, required stream-bank erosion control, pastures to be contoured, and other measures important in a plan devised to provide eventually complete control of all run-off water on the farm.

BY GIVING careful consideration to outlet locations and the establishment of vegetation before permitting any flow of water, the South Carolina farmers and engineers are able to take advantage of natural vegetative development. This allows also the location of strategic points for disposal of water and their reinforcement with vegetation, thus securing greater distribution of outlet water and less concentration in channels.

Engineers and farmers in this region have found that by sprigging the channels a satisfactory vegetative stand can be established at about one-fourth the cost of strip-sodding—a procedure necessary when the channels must take concentrated water immediately. The actual cost of strip-sodding 6 outlet channels of about average size in one of the camp areas was 50 cents per linear foot of channel. The average cost of

[1] In Charge, Information, Soil Conservation Service, Spartanburg, S. C.



NOTES:

1 - 500 ft. R.M.B. T.O.C.
2 - 970 ft. Meadow Strip T.O.C.
3 - 450 ft. Bermuda Sod T.O.C.
4 - 600 ft. " Sod T.O.C. & 600 ft. R.M.B. T.O.C.
5 - 250 ft. High Velocity Channel.
6 - Push in and terrace across small gully.
7 - 200 ft. Bermuda Sod and 1,000 ft. Meadow Strip T.O.C.
8 - 20 Brush Check Dams in Gully.
9 - Loose Rock Check Dams Reinforced with Vegetation.
10 - 3 Brush Check Dams in Gully.
11 - 600 ft. Diversion Ditch.

A typical water disposal plan.

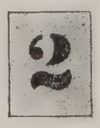
preparing and sprigging 5 similar channels in the same area recently and considerably in advance of terracing was 14 cents per linear foot.

The practice of allowing vegetation to become established in the channels before concentrated water is turned on to it should lessen the maintenance cost necessary to keep the channel functioning properly. This is emphasized by experience in South Carolina with sod-stripped channels which were used to carry concentrated water before the roots had become firmly established. In the event of heavy rains the sod was washed out. Eliminating maintenance work will make the channels more effective and further reduce costs.

WHEN the farmer has in hand a copy of the complete water-disposal plan and knows that it is a part of his agreement he has a better understanding of the complete program needed to check erosion on his farm. It also shows him a starting point as well as a definite goal toward which he can work. Usually a farmer does not terrace more than a fourth to a third of his land in a season; but with a complete plan in mind he can start vegetation on all outlets, and build the terraces as time permits during the next several years. With completion of the system in sight, the farmer has every incentive to speed up terracing.

This meadow strip is making hay, as well as establishing a dense sod of vegetation to take care of water that later may be terraced into it.

The water-disposal plan permits the engineer to make fewer trips to the farm while at the same time it allows him to render a more complete technical service to the farmer on control of run-off water. The plan affords the supervising engineer the opportunity to maintain better control of the recommended practices, and gives him the chance to discuss with



his assistants all possible methods of treatment before the agreement is signed.

Before adoption of the plan, the South Carolina engineers were pushed to keep a jump ahead of the tractors and terracing machines that were being operated on camp and project areas and by cooperative soil-conservation associations. Now they have completed advance water-disposal plans on all cooperating farms in camp areas, and in all project areas except the two oldest in the State where work was almost completed before the plan was inaugurated.

In the camp areas alone there are now complete water-disposal plans covering 110,000 acres of land under agreement and still to be terraced—this being twice the amount of land terraced in the area during the last 2 years. In the plans for the farms, 1,064 terrace outlet channels and 192 meadow strips are provided for and these are being established as fast as the cooperating farmers and the C. C. C. boys can do the work. In the last 7 months 50 of the outlet channels have been prepared and sprigged to Bermuda grass and other vegetation.

Before the system of making advanced water-disposal plans was initiated, the amount of work available for C. C. C. camp crews was largely determined by the number of tractors operating in the area. Now, however, the plans provide an almost unlimited amount of work that can be done on outlets, and this regardless of the number of tractors or whether or not it is too wet for them to operate. The work to be done in establishing the outlet channels in advance of terracing is also very largely of a type which the farmer himself can do with ordinary labor and farm equipment.

When the erosion-control program was first started in this region, tractor crews had to be put to work and demonstration terraces had to be built quickly, often without consideration of proper outlets. In those days masonry structures played a big part in the program. Vegetation was slow, and speed was the watchword.

As more and more experience was gained the emphasis shifted to more practical vegetative protection, and it was realized that concentrated water from terraces could not safely be turned onto newly planted vegetation. It was with the idea of establishing the vegetation first, and at the same time giving the engineer better control over the water-disposal program, that the South Carolina workers, in August 1936, initiated the complete water-disposal plan as a requirement supplementing all cooperative agreements in the State. Although the establishing of outlet channels and meadow strips prior to the building of terraces has been practiced in a number of locations throughout Region 2 as a whole, the complete water-disposal plans were not developed extensively in any area other than South Carolina.

According to John Downing, the associate agricultural engineer directing the work in South Carolina, one engineer was able to make the usual water-disposal plan for a 100-acre farm in about a half day. A good draftsman can make the tracings to be blueprinted in 2 or 3 hours, and the total cost other than the engineer's time for making the average plan is between $2 and $3. This cost has been far more than offset by the decreased cost of vegetating channels in advance and the other advantages of the plan.

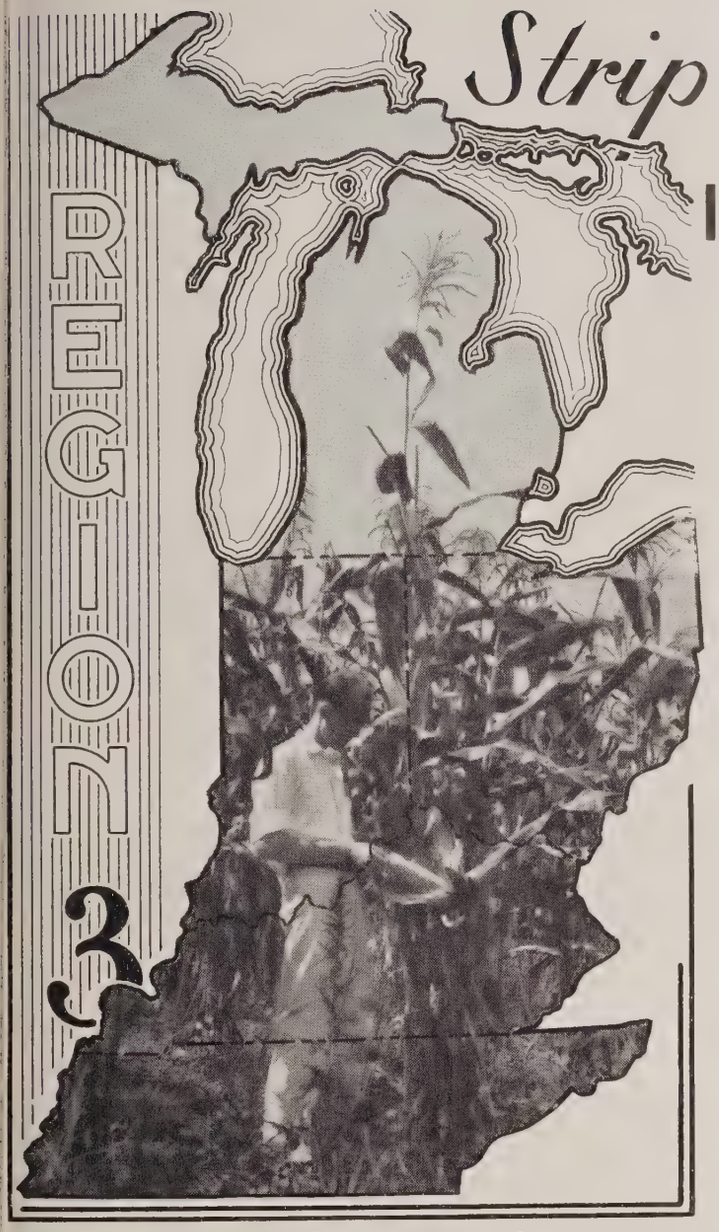
The engineer when making the water-disposal plan determines by the general lay of the land where outlet channels will be needed and what type should be established. The channel is then prepared, fertilized, and sprigged with Bermuda grass simply by scattering sprigs of grass over the area and turning them under, or is planted to other suitable vegetation. Bermuda

grass is established only in the center of the channels, some other vegetation such as lespedeza sericea being used on the edges to prevent the Bermuda from spreading into the field. Channels prepared in this manner normally are ready to take water from terraces in about 6 months. Meadow strips may normally take water with the second-year growth.

Many of the water-disposal plans call for trees and other vegetation to thicken portions of wooded areas. In about a year's time much can be accomplished toward thickening such areas so that they can safely take water from terraces and outlets. The plans also provide for gully control in the form of tree and other vegetative plantings, as well as diversion of water

(*Continued on p. 167*)

Strip Cropping In Hill Country of OHIO



Twelve-foot hybrid corn on a 20-percent slope. The field is being farmed in strips.

By J. S. Cutler [1]

FARMERS in narrow White Eyes Valley are making things a lot easier for Carl Schwab, who grades the roads through that part of Coshocton County, Ohio. Strip farming, something that would have shocked their fathers—and still shocks some of them—has penetrated this little gorge which feeds the muddy Tuscarawas.

Clark Bahmer, who had never heard of the Soil Conservation Service, started it. Zeno Hawk, 5 miles down the road, laid out his own strips when he bought his father's farm. Neighbors read about it, saw it, tried it, and liked it. Now, along the winding macadam road bordering White Eyes Creek travelers view a panorama of winding strips and contour bands. And the soil doesn't wash down on the highways so much. The operator of a road grader will tell you that.

WHITE Eyes Valley is small, yet the spread of strip cropping into the hill country is typical of the growth of this soil-saving practice in rolling Ohio.

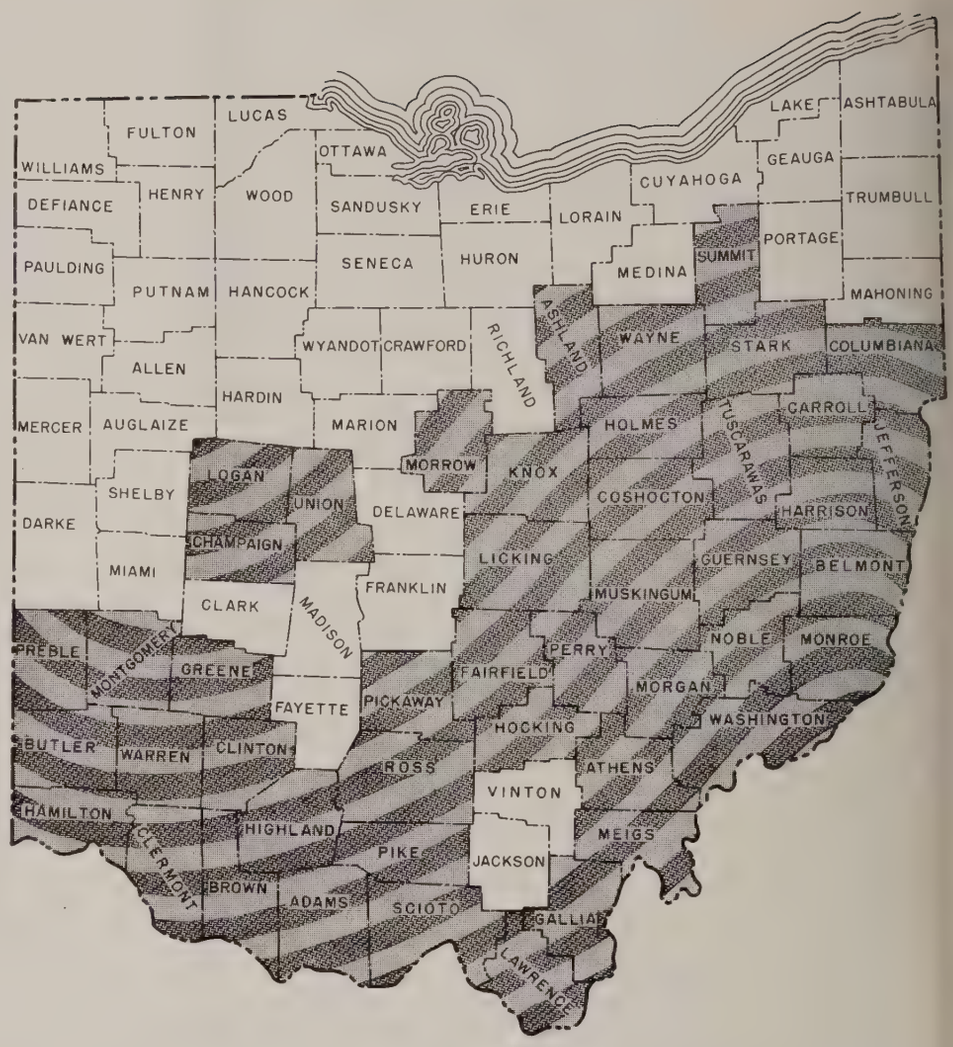
County agents have their hands full answering questions and requests. Farmers who have adopted it say they "would not go back to the old-style farming for two thousand dollars." Ohio farm journals and newspapers are full of it. Tours of soil conservation projects send farmers back home to "try it." At least one farmer in every township in Jefferson County adopted strip cropping in 1937. Out of 1,791 farms in Hocking County, 3 were laid out in strips in the same year—the beginning of the practice for that area. "You try it, and I'll watch it," as one farmer told his neighbor, has become "I believe I'll try it."

TO FOLLOW the spread of strip cropping in Ohio a knowledge of the State's topography is necessary. The surface features range from level plains with not more than 10 feet variation in elevation for several miles, to rough hills with steep slopes rising almost precipitously to a height of 300 to 500 feet above the valleys. The southern and eastern portions, known as the hill country, consist of a succession of hills and sharp, winding ridges, separated by deep, narrow valleys. It is the hill country that has grasped strip cropping as the only means of tilling land where slopes commonly run up to 30 percent.

The origin of strip cropping in Ohio is open to question, since the practice probably started spontaneously at several different places, but Belmont County is regarded as the cradle of the strip-farming system. A recent preliminary study of 25 farms in the eastern portion of the county showed that 10 farmers had been practicing strip farming for more than 25 years. Despite the fact that certain progressive farmers have been using this type of hill tillage for a generation, only in recent years has the practice spread to the southern and western parts of Belmont County, this spread being due largely to educational work.

[1] Regional conservator, Soil Conservation Service. Dayton, Ohio.

The shaded counties are those in which strip-cropping is in effect.



Of the 25 farmers included in the study, each had been strip cropping for more than 5 years. Some had learned about the practice from their fathers, others by observing the work on neighboring farms. Still others noticed that meadow strips would catch and hold the deposit from eroding fields above.

Some strip cropping began accidentally, for convenience rather than to control soil erosion. Such is the case of Herbert F. Neff, of Belmont County. Neff admits that he adopted strip cropping somewhat by accident, when he moved his fences to make his fields of suitable size to work with a tractor. The new arrangement was such an improvement in preventing soil erosion that it has been continued. The Belmont County farmer says that he not only saves topsoil, but derives more benefit from rainfall than he did formerly.

These farmers started and studied strip cropping by the trial and error method. Strips were laid out by the eye, and changed from time to time to reduce the amount of erosion. Principal changes made were the narrowing of strips, putting the strips more nearly on the contour, and lengthening the strips to facilitate cultivation of crops.

But strip cropping stayed close to its cradle. For years it did not spread, even to adjoining counties.

(*Continued on p. 168*)

The owner of this Hocking County farm, upon touring the Salt Creek project, was impressed with strip cropping and became the first in his county to adopt the practice. Note the excellent appearance of buildings and fields.

Meadow strip terrace outlet channel planted to oats and Sudan, stripped to Bermuda grass. This scene on a Garland, Tex., farm shows a complete program embracing strip crops, terraces, vegetated outlets, meadow strip outlet, and contour cultivation.

By Harold G. Anthony [1]

SINCE that eventful but unrecorded day many long years ago when the first terrace was constructed for the purpose of controlling eroding run-off, the problem of water discharge from terrace ends has been of deep concern to agricultural engineers and farmers alike. In the South, as farmers became interested in this single-phase erosion-control measure the problem was accentuated rather than solved, and at an early date it became evident that not only the success of any given terrace system, but the whole idea of terracing for erosion control was dependent upon a successful solution of the terrace outlet enigma. For many years, however, roadside ditches were washed out by red, bald-faced gullies; and sinking fence rows provided mute evidence of the futility of protecting one field with terraces while speeding destruction on adjoining areas where the water was dumped.

CONTRIBUTIONS to the ultimate solution of the problem were provided by decreased and variable grades and level terraces in low rainfall sections. But these were not enough. Simple to elaborate individual outlet and outlet-channel structures of concrete, rock, asphalt, wood, and other materials put in their appearance; and no one could deny their effectiveness nor their importance as contributions to the final solution for safely handling terrace water. Progress was being made, even though from the viewpoint of the landowner and operator these structural outlets and channels were costly and often prohibitive.

And then came the vegetation method of controlling terrace water—a procedure which, in spite of periodic appearances throughout the decades, was never widely adapted until the multiphase erosion-control program of the Soil Conservation Service began planting its roots throughout the Southland.

THIS is not an article of historical or record interest however, for the purpose of tracing developments and progress in solving the problem of handling terrace waters; nor is it claimed that the final solution has been discovered. My purpose is to explain in some detail the use of meadow outlet strips as one method of safely outletting terrace water. Like others, this method is not all-inclusive, and it can be used success-

[1] In Charge, Information, Soil Conservation Service, Fort Worth, Tex.

28593—37——2

fully only under certain given conditions; but it has proved so satisfactory wherever adapted throughout Region 4 that it is offered as one of the best.

In this region, vegetated individual terrace outlets, vegetated outlet channels, and meadow outlet strips have universally supplanted in effectiveness and desirability all other schemes of "engineered" methods for disposal of terrace water. As a matter of course, however, the method which receives first consideration by planning groups is the outletting of terrace water on to unburned properly managed woodland, well-sodded pasture, or established meadows. This, the natural and simplest plan, is used when at all possible and practical.

In project and camp areas in Region 4, as always when establishing outlets, the location of meadow strips is determined well in advance of terrace construction. In this way, the outlet strip may be well established and protected by vegetation before it is ready for actual use.

MEADOW outlet strips are located to afford protection to the maximum number of terraced acres at the minimum cost. To bring about this condition, when terraces approach the maximum desirable length if possible they are brought into the meadow outlet. In some instances a meadow strip can be located along a fence or property line where it will serve two landowners or operators. It is also necessary, when fields are unusually large, to locate meadow strips in the center of the field in order to avoid excessively long terraces.

Wherever practical, meadow outlets are used as a means to terrace outlet protection. This is especially true of Arkansas project and camp areas where the general topography of the land is such as to make the use of outlet strips both practical and economical. The strips have become very popular among cooperators and landowners outside project and camp areas, particularly because of the ease of duplication and the excellent utilization of such areas, when fenced and carefully managed, for hay crops and additional pasturage.

The meadow outlet strips should be located in a natural depression that is large enough to carry the volume of run-off diverted into it by the terrace system. Such depressions must have the lowest possible grade. It is often possible to use a location where there is a small gully or wash, by establishing the meadow on each side of the cut. Stabilization of the small gully can be accomplished by the use of sod bags or other vegetative control means. This stabilization procedure is aided by plowing in, or by any other method whereby the gully banks are sufficiently sloped to allow machinery operations and crossings. It should be pointed out here that full consideration must be given to the suitability of the site selected, and to the effect on cultivation practices in the field, before starting construction.

A minimum width of 100 feet has been adopted as standard in Region 4. This width ensures proper utilization of the meadow outlet strip and adequately allows for any abnormal rainfall that might otherwise overflow on to cultivated land. It must be constantly borne in mind in laying out meadow strips that they must have ample capacity so that water will not tend to overflow on to the cultivated area on either side.

In this region technicians have found that slopes up to 4 percent can be held by meadow grasses commonly used for hay. Bermuda grass will afford the desired protection on slopes from 4 to 6 percent. On such slopes, and on all slopes on the more erodible soil types, it is advisable to place strips of Bermuda grass sod across the meadow strip at vertical intervals of from 0.2 to 0.5 foot. These sod strips act as spreaders. For protection under normal rainfall conditions, they may extend only across the lowest part of the strip channel and it is not necessary that they extend the full width of the strip. It is also recommended that where available, Bermuda grass be used in the portion of the meadow outlet which is covered by the run-off from rains of average intensity.

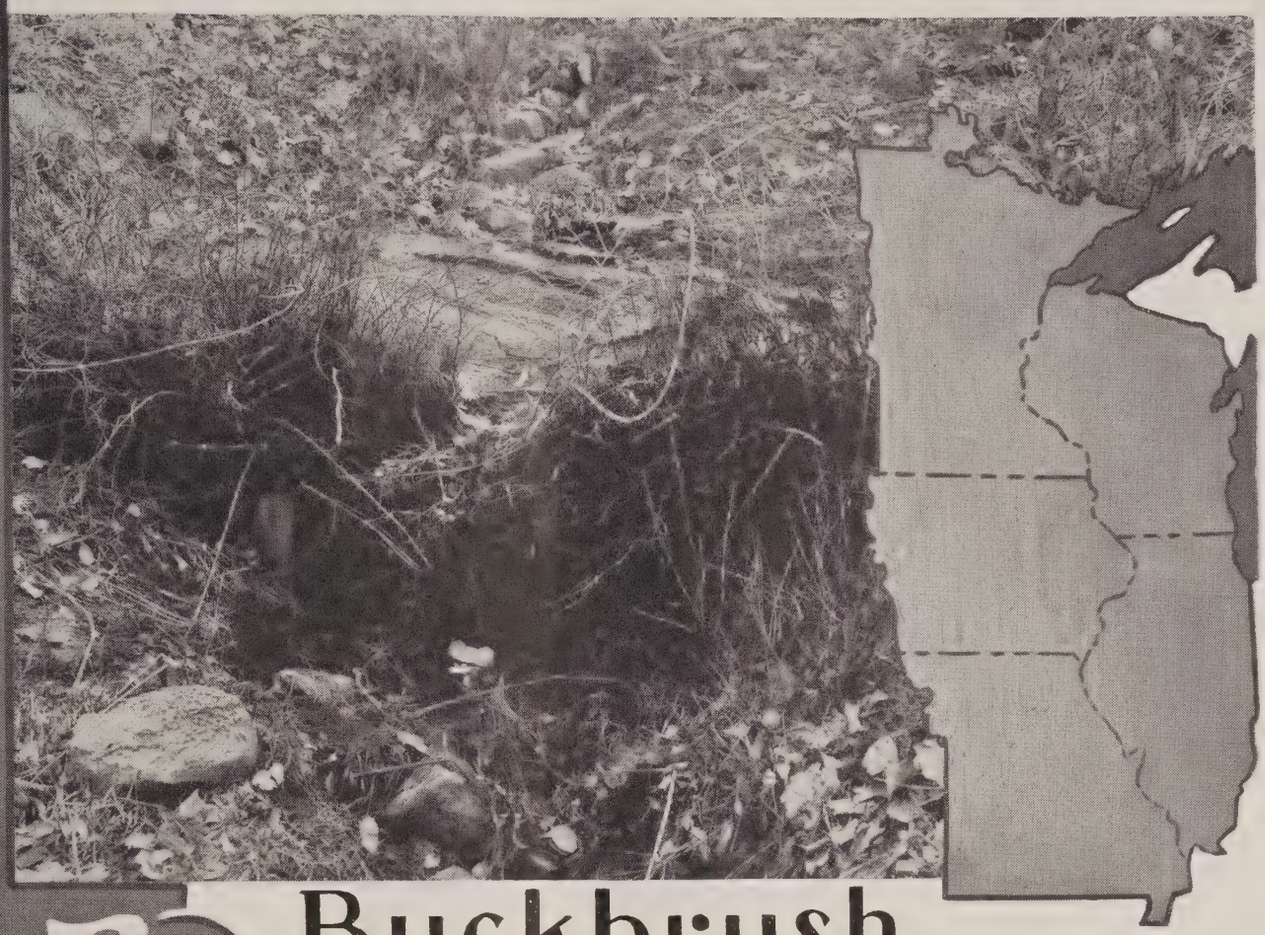
On the poorer soils where vegetative growth is normally slower, meadow outlet strips can be fertilized with barnyard manure or a complete commercial fertilizer to hasten the establishment of a protective growth.

In order to prevent water cutting back and forming a gully along the edge in the cultivated field, terraces should be constructed to extend at least 12 feet into the strip. Experience with meadow outlet strips in Region 4 has shown that the last 50 to 100 feet of terraces entering the strip should be turned somewhat downhill and the depth of the cut on the upper side gradually reduced. This will bring the bottom of the terrace channel into the strip at a point near the ground level without changing the normal terrace grade.

At present a total of 3,800 acres in Region 4 project and camp areas are being profitably utilized in meadow

(Continued on p. 170)

REGION 5



Buckbrush Check Dams

A gully completely stabilized by the diversion of water through pasture terraces, fencing out livestock, planting of trees and grass, and inexpensive brush dams.

By W. W. Russell and L. H. Kahler [1]

IN THE Dubois Creek erosion-control demonstration area near Washington, Mo., several hundred "living dams" are to be found, and they are effectively healing gullied areas. Here are structures that are mechanical treatments, and yet they are vegetative treatments as well. They require engineering designs, and yet a forester plants them.

In the past, the type of temporary gully-control structure most widely used in the Dubois Creek project was the wire-and-brush check dam. These were rather expensive both in materials and labor, and often the cost of the structure was not justified by the value of the land protected. As a result, structures were not built in many gullied areas which needed temporary stabilization prior to the establishment of vegetative cover.

[1] Junior Foresters, Dubois Creek demonstration project, Soil Conservation Service, Washington, Mo.

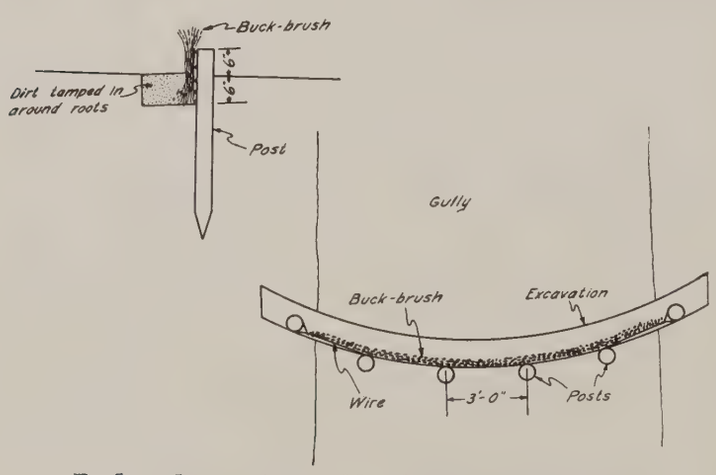
WITH these points in mind, members of the woodland management section of the Dubois Creek project last year observed that buckbrush (*Symphoricarpos vulgaris*) grew abundantly on all soil types; that it spread naturally, but could be controlled by cultivation; that it was resistant to the grazing of livestock; that it was hardy, resisting extremes in temperature; that it was an excellent soil binder, often controlling small gullies and occasionally controlling small overfalls; that it could be transplanted easily; and that it was present in sufficient quantities to be transplanted. Why not use buckbrush checks in place of the old wire and brush checks?

Accordingly the woodland management section on the project developed two types of buckbrush checks: (1) Those with a wire backing, and (2) those without wire. The purpose of the wire is to support the buckbrush at least until its roots develop and it can support itself. Experience with the structures in the Dubois Creek project indicates that buckbrush checks in gullies draining over half an acre should be backed with wire. In smaller drainage areas, the wire is not considered necessary.

Eventually, it is hoped, the living brush will spread up and down the gully, giving complete control.

IN CONSTRUCTING a buckbrush check without wire, a trench 8 inches deep is dug in a modified V-shape across the gully. Buckbrush is grubbed, obtaining a 4-inch or longer root if possible, and immediately transplanted into the trench. Soil is tamped in around the roots. Enough buckbrush is placed in the check to make a screen almost impervious to light.

In constructing a buckbrush check with wire, the same type of trench as that described above is used. Posts are made of any wood the farmer has available and driven along the downstream side of the trench, spaced 3 feet apart. Woven or barbed wire is then stapled to the upstream side of the posts, the height of the wire in the bottom of the gully never being more than 6 inches above the flow line. The height is limited to 6 inches in order to reduce the height of the backfill that will form, thus reducing the possibility



End and top views of buckbrush check dam.

of creating an overfall. Litter will soon seal the check and the backfill will develop naturally.

The roots of buckbrush should not be allowed to dry out, and it is important that the brush be planted as soon as possible after grubbing.

A unique feature of these structures is that they require no aprons. When the backfill has formed, water running over it will percolate down through the buckbrush and experience has shown that only in extreme cases does an overfall occur.

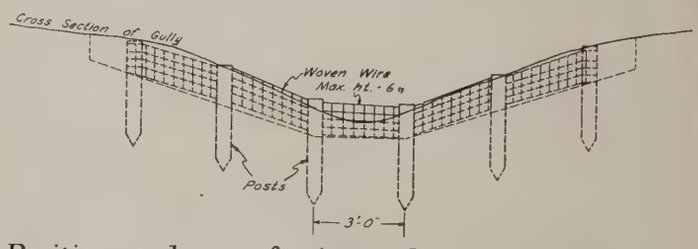
To date, 267 buckbrush checks without wire have been constructed in the Dubois Creek project at an average cost in labor of 3.8 man-hours per check. One hundred and seven buckbrush and wire checks have been built at an average cost of 6.3 man-hours per check. In most cases the only cash outlay for materials was for staples.

The first buckbrush dams were placed in the Dubois Creek project in the early fall of 1936, and buckbrush plantings were continued throughout the winter of 1936–37. A few checks were placed during the spring planting season in 1937.

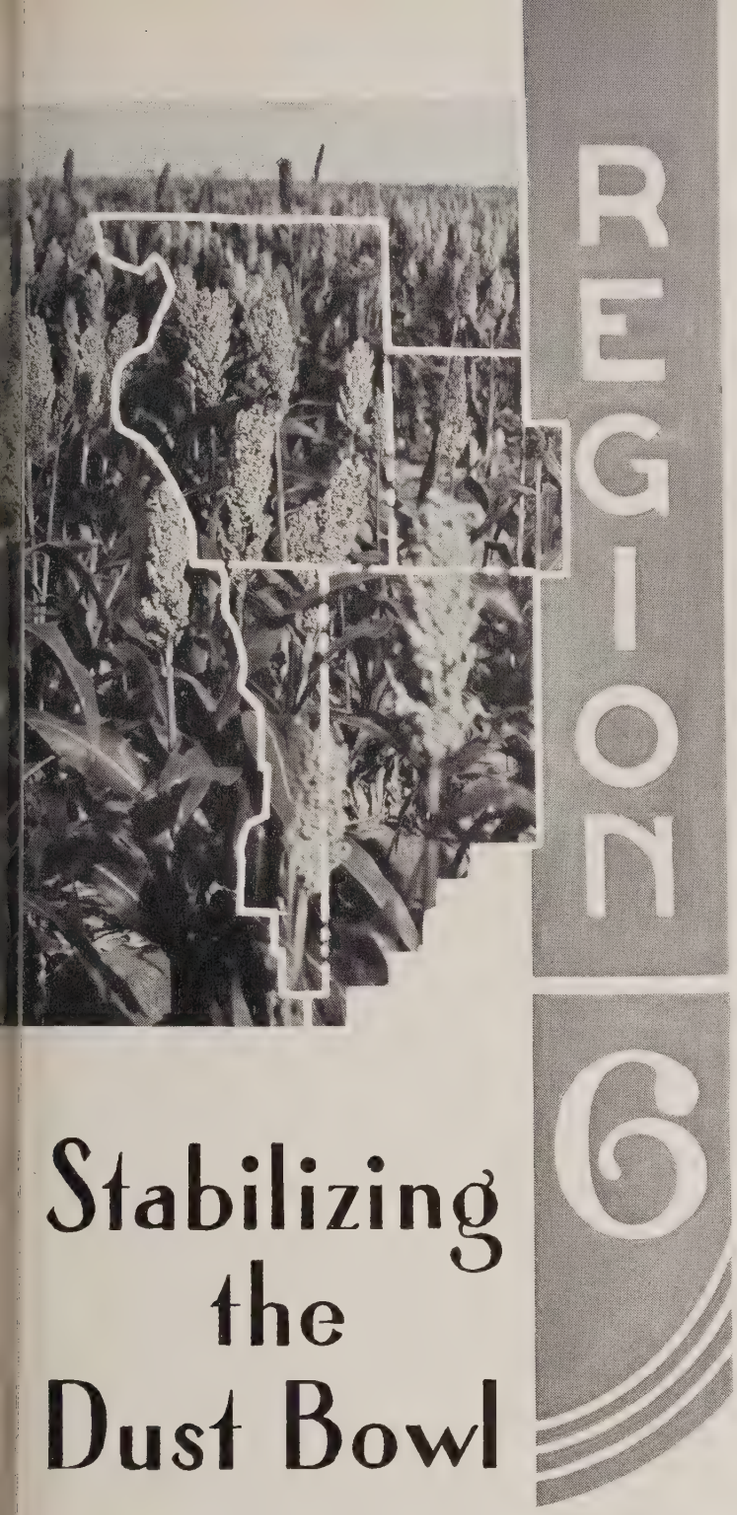
While the period during which the dams have been in use is too short to justify final conclusions concerning their value, several important observations have been made. Buckbrush checks alone cannot be expected to control gullies whose drainage areas are over 5 acres; in the larger areas other methods of control are needed. Gullies whose flow lines are so steep that checks would have to be almost on top of each other cannot be controlled by buckbrush.

The checks placed during the dry fall of 1936 and those placed during the 1937 season (a season of practically normal rainfall) have lived equally well. Though rainfall in the spring of 1937 was unusually heavy, the buckbrush has not been killed out by moisture in the gully bottoms.

To date, the buckbrush checks have been successful, and they are being watched closely for future developments. It is expected that the buckbrush will spread up and down the gullies. In discussing the dams, Dubois Creek project staff members list three advantages of the living structures: (1) They can be used in gullies surrounded by cultivated land; (2) they seem capable of stabilizing gullies in tree planting areas until the trees are large enough to take care of the erosion, at which time the buckbrush will be shaded out; and (3), perhaps most important of all, the use of buckbrush dams constitutes an erosion-control measure, which, because of its simplicity and economy, the farmers can put into effect on their own farms.



Position and use of wire and posts in buckbrush check dam.



Stabilizing the Dust Bowl

By D. A. Dobkins and Virgil S. Beck [1]

FROM the beginning, the major problem confronting those engaged in soil-conservation work in the Southern Great Plains has involved not only the stabilization of land severely damaged by wind erosion but the restoration of such land to profitable agricultural uses as well. The situation, which was the direct consequence of improper methods of land use, became acute during the extended drought period starting in 1931, when the average rainfall of 18 inches over a long period of years had decreased to 8 to 12 inches. Failure to use soil- and moisture-conservation methods had resulted in successive crop failures.

Millions of acres that had been producing bumper yields of wheat and other crops were deprived of their residue and became subject to blowing during the yearly period of high winds from January to May. Many fields lost topsoil to depths of 3 to 12 inches and hummocking resulted; while, in a few areas, notably at Dalhart, Tex., huge sand dunes were formed. Pastures in the vicinity of blowing fields were covered by the drifting soil, killing out the grasses and allowing these areas also to become subject to blowing.

AFTER studying the conditions, soil conservationists realized that special types of treatment would be required to restore the eroded lands to a point where a long-time erosion-control agricultural program could be put into operation. Some of these special treatments are here pointed out.

On severely hummocked fields where soil drifts were so high as to prevent use of ordinary farm equipment, it was necessary first to level the land to a point where it could be cultivated easily. During the emergency period it was imperative also that cropping systems be changed on most lands and that moisture-conservation practices be established over the whole area.

Wheat, the principal grain crop of the Southern Great Plains before wind erosion became so severe, no longer could be grown successfully without soil and moisture conservation.

In a majority of the wheatfields crop residues had been lost through successive crop failures; and since wheat seeded in the fall in fields lacking crop residue has little chance of maturing sufficiently to withstand the erosive action of high winds, the only alternative was the substitution of a crop better adapted to meet the emergency conditions.

FORAGE and grain sorghums, soil-binding crops which grow during the summer, were found to be suitable substitutes for wheat. These crops are of particular value because they mature fully before the high winds start blowing in the winter.

The light sandy soils, many of which prior to the period of severe wind erosion had been planted to corn, cotton, and beans presented another serious problem, as some of them were among the most severely damaged of any in the Great Plains region.

After leveling drifted fields, many farmers gave up the old cropping systems entirely and turned to grain sorghums. On many farms, however, it was found

[1] Information Section, Soil Conservation Service, Amarillo, Tex.

This wheatfield in the Stratford, Tex., project area experienced six successive crop failures. The blowing during the winter of 1936–37 left it severely hummocked.

advantageous to retain some of the crops and adopt strip-cropping plans with the non-erosion-resisting crops such as corn, cotton, and beans planted in alternate strips with the soil-binding sorghums.

The same field after adopting soil and moisture conservation practices in the spring of 1937. These included terracing and the planting of grain sorghums on the contour. Although the rainfall was less than 9 inches up to October 1, the crop matured fully. The field not only has yielded a profitable crop but now has a cover of stubble for protection during the blowing season.

As to the amount of sorghum stalk or stubble left on the fields as protection against blowing during the winter this depends on the extent of erosion in the particular area. In severely eroded areas only the heads of grain are harvested, while in the lesser affected sections a stubble of from 8 to 12 inches is found sufficient to furnish protection. In no instance has grazing on such fields been permitted, since removal of any part of the residue and the trampling of the field by livestock would aggravate the situation.

During recent dry seasons some effective water conservation was often necessary in order to obtain the first cover crop. In the semiarid plains, where the limited rainfall fluctuates widely from season to season and year to year, conservation of moisture usually is essential. On fields subject to loss of water by run-off, the land is now farmed on the contour, and, where necessary, supported by terraces. Experiment stations within the wind-erosion region have found that through this system of conserving moisture the wheat and grain-sorghum yields have increased 34 percent over a period of 11 years. Conservation of moisture increases the possibility of getting a crop and aids in leaving a good protective vegetative cover on the soil each year.

Experience in the demonstration areas of the Soil Conservation Service has proved that cash returns to the farmer using these wind-erosion control methods are greater than the cost of putting the practices into use. In addition, the farmer has protection against soil losses by wind erosion.

The first wind-erosion control project in the country was set up in August 1934, at Dalhart, Tex., at that time known as the Capital of the Dust Bowl. Since then, 26 other demonstration areas have been set up in the wind-erosion region which includes the Panhandle of Texas and Oklahoma, southwest Kansas, eastern Colorado, and eastern New Mexico. Progress in the restoration of blowing fields to profitable farming may be judged from results obtained on the Dalhart project.

When the Dalhart project was established in 1934, of the 28,765 acres taken under agreement, 23,841 had been damaged by moderate to serious wind erosion, while the remaining 4,924 acres were slightly eroded. At that time, the entire project area was subject to blowing. Soil- and moisture-conservation practices have been in use for 3 years, and today it is estimated that 25,025 acres are stabilized against blowing, while only 3,740 acres remain subject to wind erosion. These results have been obtained with rainfall of only 12.12 inches in 1935, 9.37 inches in 1936, and 12 inches to October 1, 1937. The long-time average for the project area is 17.72 inches.

On wheatlands where the accumulative effects of erosion are serious, the planting of sorghums will continue until such time as conditions will permit a safe return to wheat production. Once the land is restored to a condition suitable for wheat growth, this crop may be resumed and continued until insufficient moisture and lack of proper residue again may dictate a return to sorghums as a safety precaution against wind erosion.

(*Continued on p. 167*)

Soil-Saving Fences

By Ivy M. Howard [1]

IN THE early days many a good plainsman was shot for doing a thing now highly recommended by the Soil Conservation Service. Whole families were wiped out because of the construction of barbed-wire fences. To old-timers, the hammer blows of fence builders meant the vanishing range land and more cultivated acres. That the blows also meant the destruction of the soil on which the grass grew was to be discovered amid gasps for breath in dust-filled air by a later generation of farmers. And, strangely, it is the farmers of this generation who are now engaged in the construction of barbed-wire fences to save what is left of the range.

THROUGHOUT the Central Great Plains region, from the corn-producing counties of northern Nebraska to the cotton-growing sections of southern Oklahoma, fences are being used to save soil. Fields enclosed with contour fences are fields that are easily tilled on the contour. Fenced gullies, it has been found, are gullies that do not grow. Fenced farm ponds are ponds with dams, shore lines, and spillways not damaged by erosion. And fenced wood lots are wood lots from which raindrops never rush away as silt-laden flood makers.

"See those gullies?" Frank Kalina, Pawnee County, Nebr., points toward a nearby hillside covered with coarse vegetation as he asks the question. "A barbed-wire fence was all it took to stop them."

Fences to keep livestock off eroded acres is the price Mother Nature asks for her cooperation in providing a soil-holding cover of natural vegetation for the areas. That the price is not considered exorbitant by Central Great Plains farmers who are cooperating with the Soil Conservation Service is shown by the fact that up to July 1, 1937, more than 11,000 acres of eroding land in Oklahoma, Kansas, and Nebraska had been fenced for the primary purpose of protecting soil by protecting plant cover.

CONCENTRATION of livestock is responsible for a large part of Central Great Plains erosion. That protection of the eroded areas from livestock will retard soil movement is being demonstrated on hundreds of farms where eroding areas are now fenced. These demonstrations show that wherever plant cover is destroyed or the climax type of vegetation thinned, a natural process of restoration sets to work as soon as the cause of disturbance is removed. This means that if land is protected from grazing, fire, and concentration of run-off water, it will soon be covered with soil-holding natural vegetation.

On fenced areas where the original vegetation has been completely removed, a temporary cover of weeds

Fence placed atop terrace as field boundary. Road leads to farmhouse, on contour. Even the farmer's telephone line follows the contour.

[1] Section of Information, Soil Conservation Service, Salina, Kans.

appears. This cover is followed in order by the different types of vegetation according to the character of the land and nature of the climate. If trees grew on the land before it was plowed, shrubs begin to appear within the first 2 or 3 years. These are followed in time by trees, which are later replaced by other kinds of trees. Finally there develops a woods composed of the same kinds of trees as were cut off the land before the field was first plowed. On the other hand, if the field, or a part of it, was in prairie grass before it was plowed, the fences permit the return of the original grasses.

That vegetation is important in the control of erosion is shown by tests conducted by Dr. J. E. Weaver of the University of Nebraska. Results show that there was no water lost as run-off when 2½ inches of water was applied in 3 hours to a good stand of native prairie grass 3½ inches high. The same amount of water applied to a pasture on which the grass stands had been reduced by overgrazing resulted in 29 percent run-off, with the run-off starting 5 minutes after the first water was applied. All water leaving the closely grazed pasture area was muddy. No erosion occurred on the land protected by prairie grasses, while on the overgrazed pasture area the soil loss was 165 pounds per acre.

Fencing eroding areas and letting Nature provide the soil-holding cover ensures permanent stabilization of soil. Trees, shrubs, and grasses selected and planted by man may give quicker protection than can be obtained by natural process, but unless the artificial plantings are well adapted to their particular locations they will be only temporary. Natural revegetation must be depended upon to provide permanent erosion control.

Protecting eroding areas by the use of natural vegetation is not land retirement; it is the rededication of the land to the production of the crops for which it is best adapted. A gully controlled by natural vegetation may produce profitable crops of timber and farm wildlife; a steep slope, naturally vegetated, may, with the exercise of a little caution against overgrazing, be made to furnish economic crops of pasture or prairie hay. Stream banks with native trees and shrubs growing on them make ideal homes for farm wildlife and provide valuable crops of timber. Obviously, then, fencing land to protect natural vegetation is an important step in ensuring wise land use.

On cultivated fields of the Central Great Plains region fences also play an important role in soil conservation. They make possible rotation grazing of pastures; they provide a simple means of preventing overgrazing of supplementary pastures; and when located on the contour they solve the baffling problem of point-row elimination. Other advantages of contour fences may be pointed out. For example, on the farm of J. D. Pettit, Carter County, Okla., a relocation of field division fences made possible an increase of 80 yards in the length of rows. This allows more rapid cultivation due to a reduced number of turns. Another benefit, cited by Gans Brown, Kingman County, Kans., is that the contour field boundary roads may now follow the field boundary fences. In Allen County, Kans., Beatty Ray points to fields on his farm as proof that contour fences can be used to divide a farm in such a way that the fields will not have both wet and dry areas in them at the same time. These and other benefits derived from the use of contour fences may be summed up as follows:

1. Point rows are eliminated.
2. Longer rows are possible.
3. Contour fences serve as guide lines for contour farming.
4. Fields may be divided according to soil characteristics and slope.
5. Field boundary roads may follow contour.
6. Use of strip cropping is encouraged because strips of erosion-resistant crops may be more even in width.
7. Livestock paths along fences will be on contour.
8. Levies are created, due to back furrowing, that will hold soil and water in periods of torrential rainfall.

In the Great Plains fences are important in connection with all erosion-control methods. For example, the thousands of terraces in Oklahoma, Kansas, and Nebraska would be worthless if the fences were removed from around their terrace outlet channels. Imagine too, the havoc that would ensue if meadow strips which are depended upon for control of water from terraced fields were exposed to livestock.

As for farm ponds, much has been said about their value in soil and water conservation and it is generally conceded that the best ponds are fenced ponds. Fences give farm ponds protection from erosion by ensuring a protective cover of vegetation on the pond dam, on the shores, and on the spillway. Also, many ponds have large fenced areas immediately above them to ensure a good growth of silt-settling grasses.

Grass used for erosion control needs protection and for this reason fences are extremely important in the Central Great Plains region.

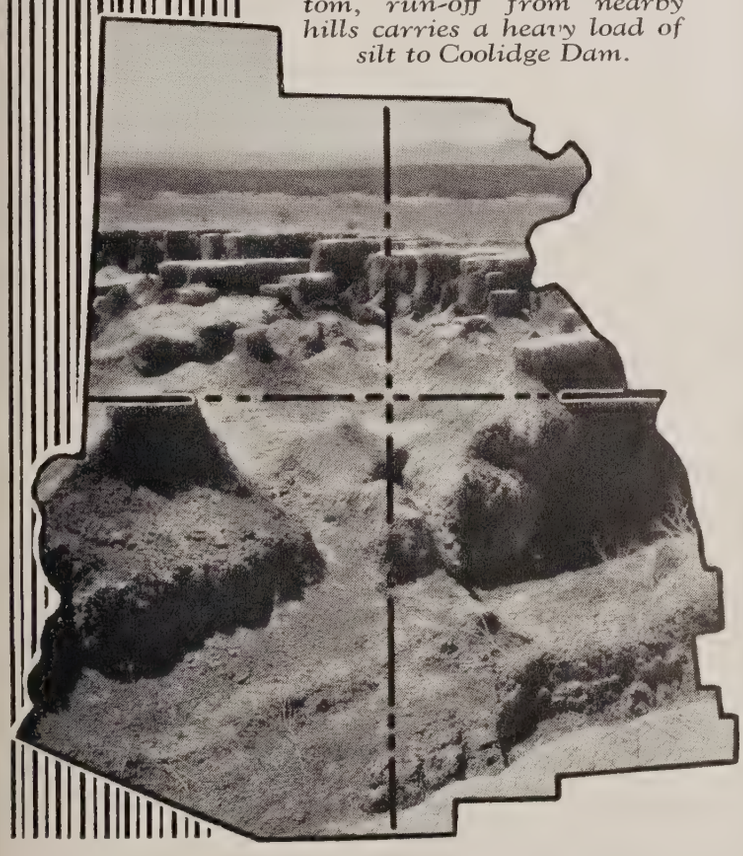
RIG-O-SOIL

Grass and Water Storage on A Quarter-Million Acre Ranch

By Kenneth M. Gapen [1]

IN THE low rainfall country of southeastern Arizona Rancher William Ellsworth and his sons operate almost a quarter-million acres of range—the biggest unit of land under cooperative agreement in any region of the Service. Ellsworth is one of the most progressive and forward-looking ranchers in range areas where the carrying capacity is low. He was one of the first to realize the need for adopting different grazing practices to save the ranges and the range livestock industry.

Active gully erosion on San Simon. Formerly a luxuriant tobosa and sacaton flat. Without grass in valley bottom, run-off from nearby hills carries a heavy load of silt to Coolidge Dam.



The Gila River flows east to west across Arizona. From Solomonville, a little town near the Service's Upper Gila district headquarters at Safford, the quarter-million-acre ranch stretches southward about 30 miles up the San Simon Valley. Its watershed drains northward into the Gila River near Solomonville.

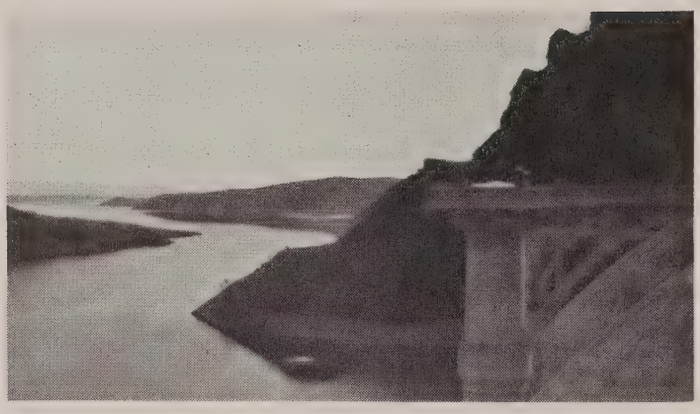
A check up on the changes that have come about on the ranch land in 51 years indicates the importance of Ellsworth's cooperation and leadership in establishing soil- and water-conservation measures.

RANCHER Ellsworth says that for some time after he came in as a partner in 1886, most of the land within 1 to 6 miles of the bottom of the valley was covered with sacaton, tobosa, and other native grasses. A part of the area was a natural hay meadow where the hay was cut, stacked, and fed out during the winter and through summer droughts. Water holes where the stock watered and stood during the summer rainy seasons were scattered along the San Simon; but nowhere along the valley was there a wash or creek. In the winter the stock found plenty of forage on the slopes along the sides of the valley.

Thousands of calves were branded yearly in the early days. Even as late as 1918, almost 2,000 calves were marked during the round-up.

DURING intervening years, however, Ellsworth has seen a steady change come over his ranch land. Today, an arroyo 20 to 30 feet deep and 100 to 600 feet wide from bank to bank cuts its way along the bottom of the valley. Water flows in it only 2 or 3 months out of the year. Practically all the good grass cover and feed is gone. The rain falling on the slopes and valley drains across the land into the arroyo and flows wildly down the wash to the Gila River.

[1] Associate information specialist, Soil Conservation Service, Albuquerque N. Mex.



Silt from San Simon and other alluvial valleys is carried by the Gila River and deposited in the reservoir behind the Coolidge Dam. Silting costs downstream farmers more than 50 cents per acre-foot and causes excess evaporation.

As it flows across the range the water picks up soil, cuts tributary washes deeper and farther back each year, and digs the soil from underneath the banks of the main arroyo and tributary washes. The sudden, heavy flash flows carry the soil down and dump it into the Gila.

What has happened to all that grass? Has the climate changed? The rancher's answer is significant in that it indicates the range practices responsible for similar changes all over the Southwest region, especially in the alluvial valleys.

"No, the climate has not changed," declares Ellsworth. "In the old days the open range and the valley meadows and grasslands got an average of 7½ to 10 inches of rain each year, just as they do today. We old-timers had our droughts just as today. But water was the big reason why the grass on the valley floor was so luxuriant. The water from the rain on the slopes drained slowly down the sides of the valley through the grass and soaked into the soil. Water that made the valley grass grow luxuriantly was really equal to about 50 inches of rain.

"Some of it collected in the scattered water holes during the summer rainy seasons. The cattle out on the adjoining hillside ranges came down 6 to 8 miles to the grassy valley bottom for water during the summer rains, staying there until the rainy season was over and the water holes became shallow or dried up. While they were there, they grazed heavily.

"But heavy grazing was not the immediate cause of the big arroyo. Along the valley and across my land ran the old wagon roads traveled by the countless 8- or 10- or 12-horse teams of the freight haulers. Many wagon trips deepened the wheel ruts until the run-off water washed down and concentrated in the wagon roadbed. When one set of ruts got too deep to drive through, the freighters moved over and dug another set to gather more water. These ruts of the old roads," the rancher explains, "were the beginning of the San Simon wash of today.

"In later years a railroad bed was built near the wagon road that was already fast turning into an arroyo. It was so near to the wash, too, that the railroad drainage helped to dig it deeper and wider."

"During the years, the grass got thinner," he added. "The water flowed down the slopes faster, cutting the side washes deeper and washing more soil into the arroyo."

Those who live where pasture grass is deep and water plentiful may not understand what has happened. Others know that the natural balance between soil, water, and vegetation in the Southwest is very delicate. The things that have happened on Ellsworth's range, as on most southwestern ranges, have upset that delicate balance.

It is important to the rancher that the valley flats will carry less than 10 head of stock now where there were 100 or more in the old days. But Mr. Ellsworth reminds us—"There were too many cattle on the San Simon range in the old days." The result is that he doesn't have the grass that he once had. The water swiftly runs off the range land because the good grass cover is not there to slow it down. Soil is lost, water is lost, and the grass plants struggle along in continual drought.

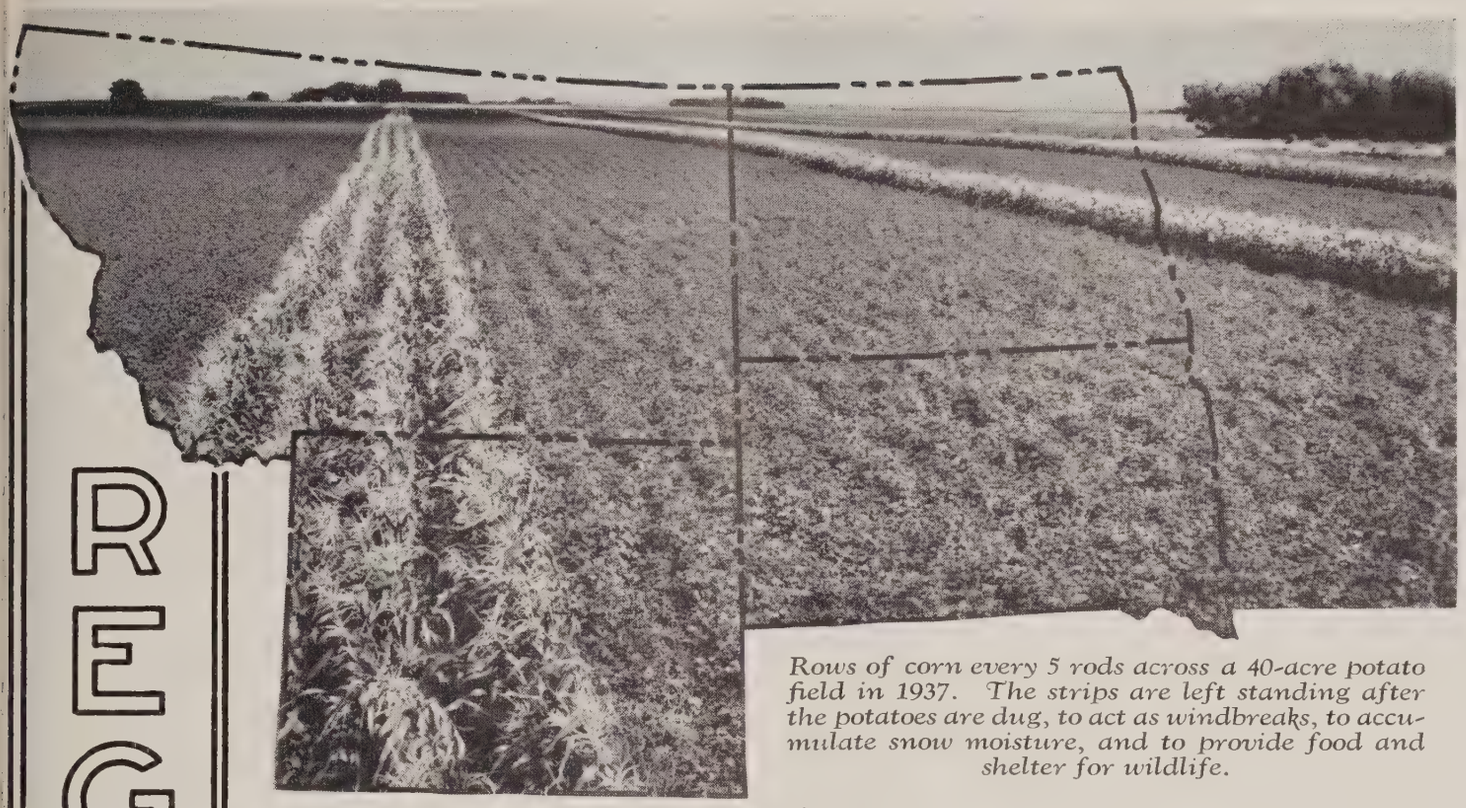
This is also important to irrigation farmers downstream. The silt from the San Simon ranges is deposited in their irrigation canals and ditches and is a big factor in slowly filling up San Carlos Reservoir behind Coolidge Dam. The water coming out of the wash only a short time each year comes in flash floods that cannot be handled by the Gila River.

Townspeople also have a deep interest in what is happening on the range, especially those who partly or wholly depend on stock raising and irrigation farming for livelihood. They are being increasingly effected because the more frequent high peaks of the Gila and other rivers in the Southwest are doing greater flood damage. And they now have more valuable property to be damaged.

Ellsworth, who saw what was happening, wanted to save the land for the future. The Soil Conservation Service surveyed his ranch holdings of private, State

(*Continued on p. 168*)

REGION 9



Rows of corn every 5 rods across a 40-acre potato field in 1937. The strips are left standing after the potatoes are dug, to act as windbreaks, to accumulate snow moisture, and to provide food and shelter for wildlife.

Wide-Row Plantings of Annuals

By Frank B. Harper [1]

THE deep, black soil of the Red River Valley in eastern North Dakota produces some of the best potatoes grown in the United States. Hundreds of carloads move on to the markets every year. It also brings forth good yields of wheat, flax, corn, and other crops.

That same deep, black soil is susceptible to wind erosion. Many miles of fence rows in the old Agassiz lake bed of glacial days often are drifted full of blown soil, swept before high winds that blow across the level land throughout several months of each year.

THE farm of William Lewis, 5½ miles northwest of Park River, N. Dak., is in the midst of the wind erosion area. When it came time for this farmer to plant his potatoes in the spring of 1936, he and technicians from the Soil Conservation Service project decided to try a new application of the wide-row planting principle. The plan was to plant a few rows of corn every 5 rods in the potato fields. It was hoped these would serve as windbreaks to protect the crop strips from the blowing.

Potatoes constitute a highly specialized clean-tilled crop. In order that every drop of moisture be made available for the tuberous crop, all weeds and other vegetative growth must be kept down. When harvest time comes in September, the potato vines are dried up. After the tubers are dug, the topsoil is left absolutely void of anchored vegetation, and is finely pulverized as a result of the cultivation and harvesting. It consequently is in the best possible condition for wind blowing.

[1] In charge, Information, Soil Conservation Service, Rapid City, S. Dak.

Tame sunflowers serve double purpose of holding snow moisture on field and providing food and cover for wildlife. Their strong stalks stand up against the wind and snow.

WHEN fall, winter, and spring winds blew over Mr. Lewis' potato field, they encountered the tall-growing rows of corn, spaced in such a fashion —at right angles to the prevailing wind direction— that the ground currents were quite completely broken up and deflected upward where they could not start soil movement. Park River Soil Conservation Service technicians watched the performance closely and with great interest. They observed that little or no soil movement occurred on Mr. Lewis' potato field. They noticed, as winter progressed, that snow was held on the fields in drifts around the corn rows, and that it stayed there and melted in the spring, adding valuable moisture to the soil. They also saw that game birds lost no time in finding the outdoor cafeteria and in taking advantage of the corn rows for shelter and travel lanes.

"That's what we have been looking for," said Project Manager Lyness G. Lloyd when with his staff he sat down to work out 1937 farm plans. The project technicians agreed. Cooperators in the area took to the idea readily.

Reasoning that if a few rows of corn were effective in helping control soil movement on potato fields, the Park River technicians concluded that this or other tall-growing annuals at most could do no harm if used in conjunction with other cropping plans. Consequently, many of the 1937 crop systems for the area called for from 2 to 4 rows of corn in potato fields, or some combination of corn and cane, Sudan grass, or tame sunflowers, between strips of land being summer fallowed, either on the contour or crosswise to the prevailing wind.

As it happened, the project technicians and their cooperators were not the only ones in the valley with sharp eyes. News of the practice spread, and this year a considerable number of farmers around Park River and Fargo followed the lead of cooperating land operators in the wide-row annual plantings.

To date the widest use of the annual windbreak principle is on potato ground and clean fallow. Increasingly popular, also, is the planting of a row of sunflowers on either side of shrub and tree windbreak plantings. Taller growing than the maize crop and hardy enough to withstand winter blasts, this woody-stalked plant stands up well through winter snows and wind.

The annual plantings serve three major purposes: (1) They deflect the wind upwards and thus shield adjacent soil from blowing; (2) they increase winter moisture retention by holding snow that otherwise would be blown away; (3) they provide wildlife food and cover.

Some cooperating farmers have seen fit to harvest at least part of the grain or seed produced on these wide-row strips, obtaining at times a considerable amount of corn on a half section or so, or a handy supply of chicken feed from sunflower heads.

This contour strip-cropped field near Park River, N. Dak., had the advantage of going into the 1937–38 winter with two rows of corn left standing as buffers to deflect the wind upward from the soil and to hold the snow. A typical water-disposal plan for a South Carolina farm, showing where terraces will drain, where meadow strips and outlet channels are needed, as well as other measures to give the farm eventually a complete system for controlling run-off waters.

Gold in the Grass Roots

By Harry E. Reddick [1]

Panning gold.

A WISE old prospector once stated that most of the big gold discoveries were not made by the prospectors themselves, but by their burros shaking pay dirt from the grass roots as they browsed. Granting that he may have been a little modest in the defense of his own calling, it is still quite true that there is more gold in the roots of the grasses than has yet been found in the ledges or veins beneath the surface.

The area that lies to the east of Sacramento, Calif., including the Mother Lode district, has long been famous for the gold it has produced. This section of the State provides two striking examples of the accumulation of wealth through grass as a medium.

A few miles out of Sacramento to the eastward lies a rolling plain criss-crossed with great wind-rows of rocks 30 feet in height and equally as wide. This is the area where the dredgers work. Huge, hungry machines that float on ponds of their own making eat away the land to a depth of 20 feet or more and pile the washed rock behind them as they creep forward. Here is an example of what gold can do to a country—gold in the pockets of the present landowners, but for the future generations, a pile of rocks forever.

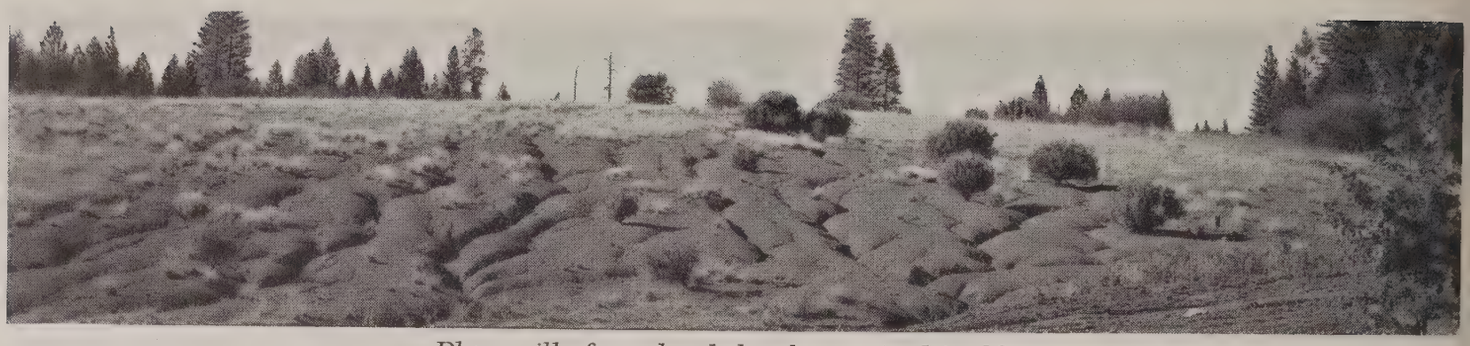
The city of Placerville nestles among the pine-clad foothills of the Sierra Nevada range some 50 miles to the eastward. Region 10 has a conservation area located there, and the orchards in this section are proof that the minted gold from crop returns is more lasting than that which is washed or mined from creeks or ledges.

Placerville, known in the days of '49 as "Hangtown," was for many years a roaring placer mining camp—with its gamblers, its boom times, and its two-gun characters who frequently played their last part doing gymnastics at the end of a hemp rope with the vigilantes as an encouraging audience.

Today, mining is of secondary importance around Placerville, and thousands of acres of the red earth that was formerly sluiced down over the riffles armed with quicksilver now are producing pears, plums, and peaches. In spite of the fact that mining is no longer Placerville's medium for prosperity, the gold-in-the-grass-roots idea still holds true, because a permanent cover crop of well-rooted grasses has proved to be the best way to keep the hillside orchards in production.

Although pears, now the principal crop around Placerville, were first introduced into California by the Mission Fathers as early as 1769, the cash value of pears and peaches probably hit an all-time high during the early days of the gold rush when it is recorded that the yield from one tree in the locality was worth $1,000 and single fruits sold for as high as $3 each.

[1] Regional conservator, Soil Conservation Service, Santa Paula, Calif.



Placerville farm land that has retired itself.

Many of the present-day aspects of fruit growing in Placerville can be traced back to the influence of the early mining activities in the region. In the first place, the start of fruit growing in the district was due directly to the demands for fresh fruit by the miners rather than for supplying eastern markets as is the case today. Many of the farms owe their location to the fact that the ground had been cleared of its pine trees

10

10

Downhill irrigation has caused much damage in the Placerville area.

by miners in search of timber for tunneling operations, or in other instances, because old placer-mining flumes could be used for irrigation.

One of the present problems confronting the Soil Conservation Service in this district is the outgrowth of a custom dating back to the days when "miner's inches" of water from the stream were allotted to each claim. This miners' measurement of water, when applied to orchards, has resulted in the farmers not having enough water at one time to irrigate in the most efficient manner. Instead of having available a large head of water for a few days and devoting his entire time for the short period to the task of irrigating, the farmer must shift his small stream every day or two; and because the flow is constant, he does not give it the attention that he would if the supply were more abundant for a shorter time.

Storage basins to enable the farmer to hold the water off his land until he has accumulated enough to permit flooding or completing his irrigation at one time have been suggested as a remedy; and some of the growers have formed agreements whereby one can use the allotment of the others for a short time and then pass it on.

Another difficulty is the loss of water due to leaks in flumes, seepage, and evaporation. These losses, estimated to be as high as 15 percent of the water entering the flumes at the stream, are being taken care of by the installation of concrete pipe lines. These pipe lines are made up of sections about 3 feet in length and of varying dimensions to fit the volume of water to be handled. The process of making these pipe sections has been highly developed in California and consists of tamping a fairly dry concrete mixture into sectional molds. Special fittings, such as head gates, vents, and outlets, are cast and later fitted with metallic parts wherever there is wear or where moving parts are required.

The use of concrete pipe in the irrigation systems has been recommended by the Soil Conservation Service because indirectly it makes possible the planting of permanent cover crops on the steep hillsides. Surveys of the area showed that, due to the orchards being planted on the square or diamond, with the irrigation down the steepest part of the slope, ranging from 10 to as high as 30 percent in grade, a great deal of soil was being lost, not only from the winter rains after the volunteer cover crop had been disked under but also from the cutting action of the irrigation water itself. It was immediately recognized that permanent cover crops would furnish the desired protection; but there was the frequently encountered objection that such crops required too much water to permit their use.

After further study it was determined that by conveying the water through concrete pipe lines rather than open ditches, a sufficient saving could be made in irrigating water to more than offset the amount used by the permanent cover crop. The prevailing practice among many of the cooperators now is to plant Italian

rye grass, clover, alfalfa, or bluegrass, and to mow or lightly disk this in the spring to prevent further consumption of moisture, leaving the roots intact and ready for the first fall rains.

In connection with this type of irrigation, the unusual practice of running furrows or "sideboards" up and down the slope at frequent intervals is often adopted. After they are seeded, these furrows prevent the water on the flooded areas from concentrating on one side of the slope and cutting gullies.

Cover crops are by no means the only preventive measure being used by the Soil Conservation Service in attempting to stop erosion in this locality. Basin listing, contour furrows, and wherever possible the changing from down the slope irrigation to across the slope are being recommended.

Unlike the early settlers in this community who tried to get the maximum erosive effect out of the water in their placer mining operations, the modern Placerville farmer is doing everything possible to use the water in a way that will prevent erosion. This is another example of a western community where irrigation practices have been the cause of a great deal of soil loss, and where a change of irrigation practices has become the objective of the Soil Conservation Service in that area.

The change of attitude on the part of the residents and surrounding farmers toward the Soil Conservation Service and its objectives has been marked indeed. In the beginning, many of the old timers living on places deeply cut by gullies were inclined to scoff at the idea of the Federal Government advising them about the dangers of losing their soil. Today, there is recognition of the dangers of erosion that makes a 3-inch rill down a cultivated slope a topic of discussion on the street and sufficient justification for the owner to call on the project manager.

Back and forth across the plains creep the dredgers, turning grasslands into rocky wastes.

Not only are they conscious of the fact that there is a problem. They are so eager for help that they readily agree to furnish most of the labor and 90 percent of all material in order to get the work done. Although it will be a year before this project goes on maintenance, there are already more surveys requested by cooperators than the project personnel can take care of.

There is still gold in the grass roots of Placerville as can be attested by Soil Conservation Service employees who have panned "color" in their own back yards. But the real wealth that is bringing life and prosperity to the community again can be found in the carloads of golden pears that follow the same trail once used by the "forty-niners" as they go down out of the mountains to the eastern markets.

WATER DISPOSAL PLAN

(*Continued from p. 150*)

from the gully where necessary to check erosion, and the filling up of small gullies and terracing across them.

Relocation of roads that otherwise would run across planned terraces or that may be required for water-disposal outlets are shown in the plans. The plans also show the engineer's rough estimate of required terrace locations. While usually it has not been difficult to determine the draws and edges of fields where meadow strips and outlet channels should be placed, often it is not so simple a matter to show the terraces in detail. The important thing in establishing the waterway, however, is determining where the terraces will drain, and this the South Carolina engineers have been able to do 90 to 95 percent correctly, Downing says.

With emphasis of the Service shifting to cooperation with organized districts, the engineers look upon the water-disposal plan as an excellent opportunity for extending technical assistance to a large number of farmers. Where the Service renders only technical assistance, we must depend on the farmer to carry out the plans. The South Carolina engineers say that farmers can and will carry out the water-disposal plans, because each plan is such that the farmer can clearly picture the complete water-disposal needs on his farm, and he can do the work as he finds the time.

STABILIZING THE DUST BOWL

(*Continued from p. 158*

On the sandier soils, the strip cropping of non-erosion-resisting crops with sorghums will be continued, with an annual rotation of the strips.

With this cropping system in operation and with full utilization of the water where it falls, there should be little danger from wind erosion in the future.

STRIP CROPPING IN OHIO

(*Continued from p. 152*)

The Salt Creek demonstration area of the Soil Conservation Service, the first to be established in the State, must be given credit for really launching the new era in hill culture. Strip farming, as Ohio knows it today, was unknown in Muskingum County when the project was launched early in 1934. More than 400 farms in the county are being tilled in strip fashion this year, and the demonstrations provided by these farms have formed the spearhead of the advance. Almost every county agent in the hill country has brought farmers in to see for themselves just what those alternate contour bands of corn and meadow are doing. From these tours has sprung a new confidence for thousands of farmers who have no level land to cultivate, and who must make their living from the slopes.

The spread of strip cropping on an extensive scale followed the establishment of additional projects and the allocation of a score of C. C. C. camps to the Service. The extension soil conservationist and the Ohio State University extension agronomists, alert to the possibility of strip cropping as the solution to the erosion problem, cooperated enthusiastically with county agents and with farmers. By 1936 systematic strip farming was being demonstrated in every section of the hill country, and it continued to spread.

Farmers began demanding help. County agents were far too busy to meet all such requests and keep up their normal work at the same time. The stage was set for the next act in the spread of strip cropping. In November 1936 the Soil Conservation Service, cooperating with the Ohio Agricultural Extension Service, set out to carry the gospel of soil conservation to southeastern Ohio farmers outside project and camp areas. To meet the demand, R. L. Bazler, conservationist, was delegated to re-plan those farms recommended by the Agricultural Extension Service and the county land-planning committee. Twenty-four typical farms in 12 hill counties have been selected as demonstrations, and the initial success accorded this phase of the work portends expansion of the experiment.

By midsummer in 1937 more than 21,000 acres within project and camp areas had been strip cropped. From a permanent standpoint, more important was the fact that farmers in at least 46 counties in the State had adopted this type of soil conservation.

But what of these farmers who have adopted the measure voluntarily? Will they continue the practice?

Their remarks are singularly uniform. That from Wayne Thompson, Monroe County, is typical: "It's a lot easier to plow than before. The team does not have to drag the plow up hill, I can plow more ground now, and I am not as tired at night. It has stopped the washing."

It's the same with tractor operators. They admit freely that strip cropping saves time and labor costs. And when they harvest 60-bushel corn from a 20-percent slope, they tell the neighbors who have been watching those crazy bands which have become the all-year fashion for Ohio hill farms, what strip cropping can do for their sloping cornfields.

GRASS AND WATER STORAGE

(*Continued from p. 162*)

leased, and public-domain range, to find out how many cattle the land would carry. In the Southwest, the first step in protecting the range from soil erosion is a readjustment of livestock numbers to fit carrying capacity. This step in management is a prerequisite to operations. Grazing control gives the grass on the range a chance to come back. This recovery takes time—much time in a badly depleted, low rainfall area.

The range survey was made on the ranch in 1935. The next year the stocking of the range was reduced to the safe carrying capacity as indicated by the survey. Fifty-eight miles of fence was built to keep livestock from trespassing on the controlled range, and as an aid to proper distribution of cattle over the range. The next step was the construction of 14 stock water tanks for proper distribution of water supply.

The range surveys showed that the entire Ellsworth ranch would carry about an average of four head of cattle to the section. Some of the sections were so bare of forage that grazing capacity was nil. Some were better grassed and would carry 16 head a section or more.

Ellsworth had four sections of range along the bottom of the valley. He had fenced this pasture 20 years ago and had used it wisely and protected it from soil washing through the years. These four sections were covered with an excellent stand of tobosa and sacaton grasses that would easily carry 20 head of cattle a section. During the summer rainy season they would feed many more cattle. To the Service surveyors this was an indication of what widespread management and improved cover can do in controlling erosion and feeding the cattle.

(*Continued on p. 170*)

Above—Hay crop grown in a gully, seeding consisting of alsike, brome, meadow fescue, and redtop.

Below—The way straw farming looks most of the time.

A one-way disk plow at work.

Straw farming

By C. R. Briggs [1]

THROUGHOUT the past, straw farming has many times demonstrated its value. It "puts back" as compensation for "taking off" the land. When the straw in the rotting process becomes humus it improves the soil's fertility and water-holding capacity. At the same time it conditions the land so that it works easier. Also, in the blow country of central Washington and along the Columbia River in Oregon, straw farming is considered one of the most effective methods for pinning down the land.

In the Palouse hills, straw farming, combined with two other practices—rough tillage and cross-slope cultivation—is now employed to prevent washing.

LET us see these three cultivation practices at work on the farm of Elmer Meiners, 6 miles east of Walla Walla, Wash. In the first place, Meiners spread the straw on all his fields using a spreader on his combine harvester. In the fall of 1935 he chiseled 13 acres. An old plow beam with hardened point was used to break up the soil, down through a compact layer to a depth of 12 inches. The straw was left to lie as it fell on the top of the land.

An adjacent 25 acres was worked with a one-way disk plow, leaving the straw partially anchored and forming myriads of small obstructions to water racing over the surface, and at the same time providing an

[1] In Charge, Information, Soil Conservation Service, Spokane, Wash.

(*Continued on p. 170*)

BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

THE EFFECT OF LAND USE AND MANAGEMENT ON EROSION. By E. H. Reed and J. I. Falconer. Ohio Agricultural Experiment Station, Wooster, Ohio. July 1937

A report based upon a study of 100 farms located in four Soil Conservation Service demonstration areas in Ohio. The data were obtained by the survey method in 1936 and include information from land owners and tenants, past and present, concerning soil types, slope acreage, erosion, cropping and animal units, income from crops and livestock, land cover, cropland distribution by slopes, erosion-resistant and erosion-favoring rotations, use of fertilizers and lime, tenure and mortgage, yields and income. The object of the study was to determine to what extent quality of farming and management, as well as organization and land use, are factors of importance in the control of erosion on farms with similar soil type and topography under similar climatic conditions. The study was a joint project of the Ohio Agricultural Experiment Station and Region 3 of the Soil Conservation Service. The 100 farms studied are located in the Salt Creek, Muddy Fork, Granny-Dry Creek, and Indian Creek areas.

STRAW FARMING

(*Continued from p. 169*)

equal number of leadways for the water to follow down into the soil.

Then there was a third field on which the stubble was burned, leaving the land to lie bare over the winter.

Most of the moisture that makes the wheat crops of the Pacific Northwest comes in the winter; therefore, in the spring of 1936, these three fields stood ready as demonstration plats to show what straw farming, when combined with rough tillage and cross-slope cultivation, would do in the way of holding the moisture for the spring-planted crop.

The story of the straw on the 13 acres of chiseled land can be told briefly: There was no run-off. From the 25 acres which had been worked with the one-way disk plow a little water trickled and oozed off the lower end. The burned plowed land was cut into ribbons. Every 3 feet the run-off had washed out rills that averaged 4 inches in width and 3 to 6 inches in depth. The average soil loss from this field would amount to approximately a foot of topsoil in 40 years.

The comparisons seem to favor chiseling. The expense factor enters here, however, since after chiseling the seedbed must be prepared as an extra operation. The one-way disk plow does a complete job and does it at less expense.

This demonstration, along with others, has carried conviction to farmers both on and off the projects. At Walla Walla, where Meiner's farm is located, three straw spreaders were available when the project was established in 1935. (Here it is well to remember that the straw must be spread behind the combine harvesters before it can be worked into the soil with any implement.) Now the 44 cooperators have 20 spreaders and these serve everyone. Eighty percent of the land in the community is "straw farmed." On the Pattit Creek project, 20 miles from Walla Walla, the one straw spreader that was available in 1935 has been put to work again and 15 others have been purchased. Nine one-way disk plows adequately serve the whole community. In the Moscow-Pullman area, crop residues are being utilized on 40,240 acres of land.

GRASS AND WATER STORAGE

(*Continued from p. 168*)

It would take time to bring the grass back on the ranch land through grazing control alone. To help check soil washing and protect the grasses, some of the worst gullies were worked on. In some places the water was spread out over the land, and fences and stock-water tanks helped distribute the home stock and kept out trespass stock. All these mechanical devices aid in the control of erosion and prevent damage to irrigated lands and silting of reservoirs in the Southwest range country.

Mr. Ellsworth tells us that his range is already improved. He believes in properly stocking and managing range land to improve the cover to raise livestock more efficiently, and to check soil and water losses.

He understands that the tremendous quantities of silt washed into the reservoirs and irrigation systems come from the banks of the meandering washes, the tributary gullies, and the widening arroyo channel on his holdings and on other ranges of the lower valley.

Stockmen, farmers, and townspeople are all directly concerned with and affected by soil erosion in the Southwest.

MEADOW OUTLET STRIPS

(*Continued from p. 154*)

outlet strips. The strips vary in size from less than 1 acre to the largest in the region (located in the Minden, La., C. C. C. camp area) which is 4,300 feet long and handles the drainage from 185 acres of land.

Where they are fenced, and if carefully managed, meadow outlet strips may be grazed. Stock should never be allowed on the strips during rainy weather, however, and must not be left at any one time long enough to form trails or to injure the vegetative cover. Because of the extra water that is made available to pasture grasses and clovers growing in the outlet strips, unusually good yields of hay are cut from them.

U. S. GOVERNMENT PRINTING OFFICE: 1937

1937 Publications of Value In Soil Conservation Work

For REFERENCE
Compiled by Mrs. ETTA G. ROGERS, Publications Unit

(Field offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue)

Soil Conservation Service

Erosion Control in the Northeast. Regional Office, Williamsport, Pa. 1937.

Preliminary Report: Economic Survey of Clovis, New Mexico, Project Area. S. C. S. Regional Office, Amarillo, Tex., in cooperation with the N. Mex. Agricultural Experiment Station and Extension Service, and the Bureau of Agricultural Economics, U. S. Department of Agriculture. mm. July 1937.

Problems and Needs of Soil Conservation. Address by H. H. Bennett at the Annual Conference of Extension Workers, Purdue University, on Oct. 7, 1937. mm. SCS-MP-18. Oct. 1937.

[1] Soil and Water Conservation Investigations. Progress Report, 1932-35, Upper Mississippi Valley Soil and Water Conservation Experiment Station, LaCrosse, Wis. mm. SCS-ESR-1. Sept. 1937.

[1] Soil and Water Conservation Investigations. Progress Report, 1930-35, Red Plains Soil Conservation Experiment Station, Guthrie, Okla. mm. SCS-ESR-3. July 1937.

[1] Wildlife Management—Erosion Control in the Central Great Plains Region. A handbook for Soil Conservation Service Technicians. Regional Office, Salina, Kans. mm. SCS-RB-6. Aug. 1937.

Office of Information, U. S. Department of Agriculture

Planting and Care of Shelterbelts on the Northern Great Plains Farmers' Bulletin 1603. Issued Aug. 1929, rev. Aug. 1937.

Some Moisture Relations of the Soils from the Erosion Experiment Stations. Technical Bulletin 562. July 1937.

Agricultural Experiment Station

Agriculture on the Huntley Project. Bulletin 342. Agricultural Experiment Station, Bozeman, Mont. June 1937.

Conserving Soil by Strip Cropping. Circular 368. Extension Service, University of Missouri, Columbia, Mo. June 1937.

Corn Production on the Campbell County Experiment Farm. Bulletin 223. Agricultural Experiment Station, Laramie, Wyo. Sept. 1937.

Crop Regions in Montana as Related to Environmental Factors. Bulletin 340. Agricultural Experiment Station, Bozeman, Mont. May 1937.

Effect of Land Use and Management on Erosion. Bulletin 585. Agricultural Experiment Station, Wooster, Ohio. July 1937.

Effects of Fertilizers on the Productivity of Sagemoor Fine Sandy Loam Under Irrigation. Bulletin 346. Agricultural Experiment Station, Pullman, Wash. Apr. 1937.

Fertilizer and Crop Experiments on Certain Soils of the Black Belt. Circular 78. Agricultural Experiment Station, Alabama Polytechnic Institute, Auburn, Ala. July 1937.

Fertilizer Experiments with Cotton in Type-of-Farming Areas. Bulletin 346. Agricultural Experiment Station, Fayetteville, Ark. June 1937.

Fitting Sheep Into Plains' Farming Practices. Bulletin 436. Agricultural Experiment Station, Fort Collins, Colo. Sept. 1937.

Forest Lysimeter Studies Under Red Pine. Bulletin 394. Agricultural Experiment Station, New Haven, Conn. June 1937.

Increase Quail by Improving Their Habitat. State Game, Fish, and Oyster Commission, Austin, Tex. May 8, 1937. 10¢.

Influence of Tenancy on Types of Farming and Agricultural Income by Soil Types, Minidoka Irrigation Project. Bulletin 222. Agricultural Experiment Station, Moscow, Idaho. June 1937.

[1] Issued for use by S. C. S. staff and cooperating officials only.

Land Utilization in New Hampshire: I. Problems in the Back Highland Areas of Southern Grafton County. Bulletin 298. Agricultural Experiment Station, Durham, N. H. June 1937.

Legumes in Cropping Systems. Bulletin 374. Agricultural Experiment Station, Lexington, Ky. Aug. 1937.

Lespedezas in Kentucky. Circular 297. Extension Division, University of Kentucky, Lexington, Ky. May 1937.

Natural Vegetation of Arizona. Technical Bulletin 68. Agricultural Experiment Station, Tucson, Ariz. July 15, 1937.

Need for Woodland Improvement in Indiana. Extension Bulletin 221. Extension Service, Purdue University, Lafayette, Ind. July 1937.

Responses from Various Sources of Nitrogen Fertilizer. Bulletin 309. Agricultural Experiment Station, Clemson, S. C. May 1937.

Results of Experiments, 1932-1936, Inclusive, Dominion Forest Nursery Stations, Indian Head and Sutherland, Sask. Dominion Experimental Farms, Department of Agriculture, Dominion of Canada, Ottawa, Canada. 1937.

Results of Experiments, 1931-1936, Inclusive. Experimental Station, Swift Current, Sask. Dominion Experimental Farms, Department of Agriculture, Dominion of Canada, Ottawa, Canada. 1937.

Soil Conservation Program for 4-H Clubs. Club Bulletin 33. Extension Division, Michigan State College, East Lansing, Mich. May 1937.

Soil Drifting Control in the Prairie Provinces. Publication 568, Farmers' Bulletin 32. Department of Agriculture, Dominion of Canada, Ottawa, Canada. May 1937, second revision.

Soil Erosion and Its Control. Circular 304. Extension Division, University of Kentucky, Lexington, Ky. July 1937.

Soil Erosion in Michigan Orchards. Circular Bulletin 162. Agricultural Experiment Station, East Lansing, Mich. June 1937.

Strip Cropping in Southwestern Pennsylvania—Preliminary Report. Paper 783. Agricultural Experiment Station, State College, Pa., in cooperation with the U. S. Department of Agriculture (Soil Conservation Service and Bureau of Agricultural Economics). mm. Aug. 1937.

A Study of Land Utilization in Washington and Kent Counties, Rhode Island. Bulletin 261. Agricultural Experiment Station, Kingston, R. I. June 1937.

A Study of Utah's Winter Range: Composition of Forage Plants and Use of Supplements. Bulletin 277. Agricultural Experiment Station, Logan, Utah. June 1937.

Systems of Farming and Possible Alternatives in Nebraska. Bulletin 309. Agricultural Experiment Station, Lincoln, Nebr. June 1937.

Twenty-One Years of Crop Yields from Cottonwood Experimental Farm. Bulletin 312. Agronomy Department, South Dakota State College of Agriculture and Mechanic Arts, Brookings, S. Dak. May 1937.

Type-of-Farming Areas in New Hampshire. Circular 53. Agricultural Experiment Station, Durham, N. H. June 1937.

Types of Farming and Farm Business Studies in South Carolina. Bulletin 310. Agricultural Experiment Station, Clemson, S. C. June 1937.

Use of Native Grass in Producing Finished Cattle. Bulletin 307. Agricultural Experiment Station, Lincoln, Nebr. June 1937.

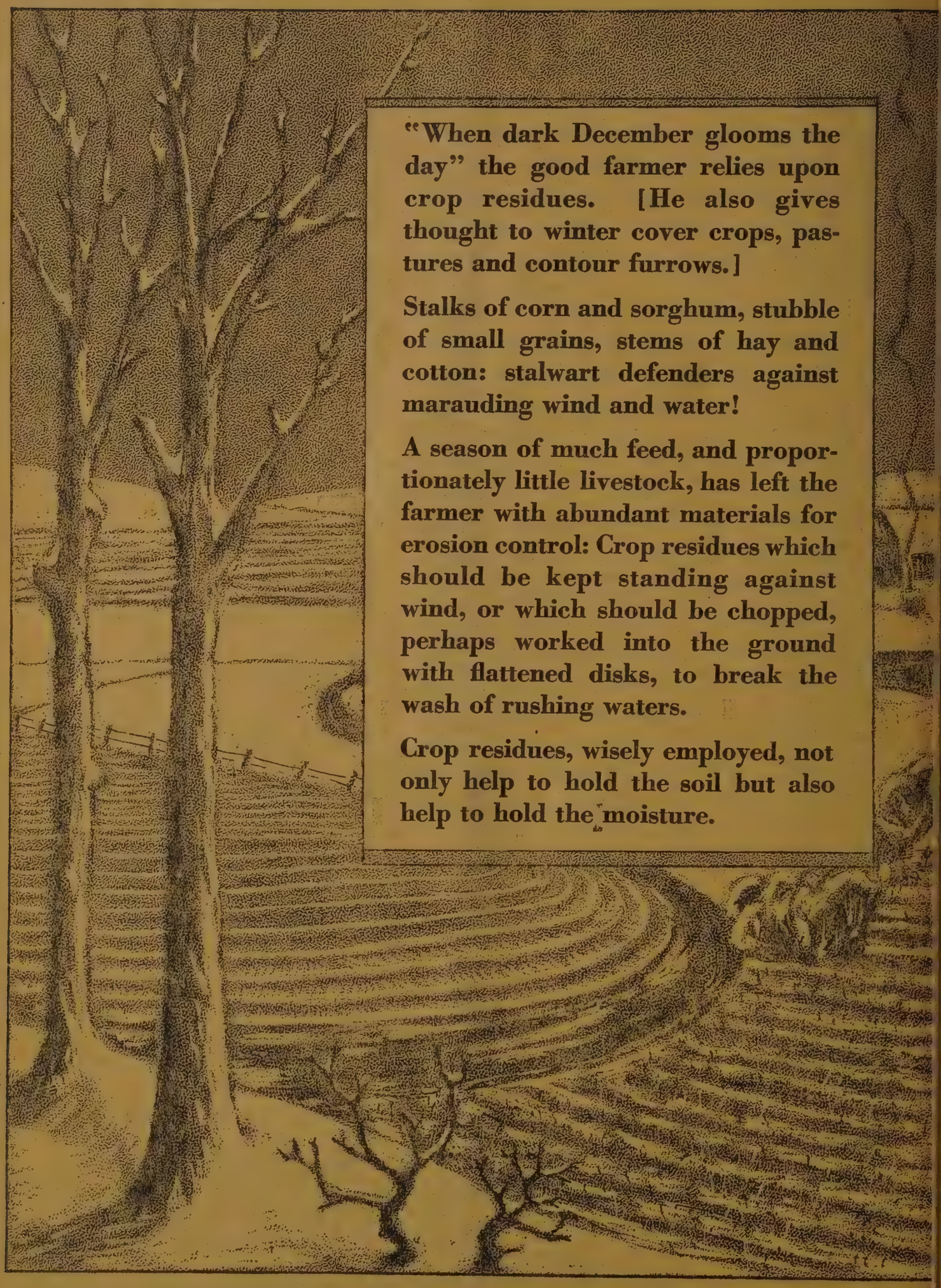
Variety and Inter-Cultural Experiments with Cowpeas. Bulletin 343. Agricultural Experiment Station, Fayetteville, Ark. June 1937.

West Virginia Pastures: Type of Vegetation, Carrying Capacity and Soil Properties. Bulletin 280. Agricultural Experiment, Station, Morgantown, W. Va. June 1937.

A Year's Progress in Solving Farm Problems of Illinois, 1935-36. Agricultural Experiment Station, Urbana, Ill. 1937.

Miscellaneous

Regional Planning, Part V—Red River of the North. National Resources Committee. Aug. 1937.



"When dark December glooms the day" the good farmer relies upon crop residues. [He also gives thought to winter cover crops, pastures and contour furrows.]

Stalks of corn and sorghum, stubble of small grains, stems of hay and cotton: stalwart defenders against marauding wind and water!

A season of much feed, and proportionately little livestock, has left the farmer with abundant materials for erosion control: Crop residues which should be kept standing against wind, or which should be chopped, perhaps worked into the ground with flattened disks, to break the wash of rushing waters.

Crop residues, wisely employed, not only help to hold the soil but also help to hold the moisture.

So 3-5

SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE · WASHINGTON

U. S. F. S. RECEIVED
LIBRARY
JAN 19 1937

JANUARY - 1938

Contents

Page

620 Miles of Contour Furrows Stabilize the Pocatello Hillsides:
By Glenn M. Querna 171

The Living Soil:
By Selman A. Waksman 173

The Beaver as an Upstream Engineer:
By Paul M. Scheffer 178

Synthetic Growth Substances, a New Development:
By V. T. Stoutemyer 182

Agronomic Briefs:
By C. R. Enlow 185

Blotters Instead of Shingles:
By Wellington Brink 186

The Reclamation of a Sand Dune Area:
By Charles J. Whitfield and Fred C. Newport 190

Basin Listing to Retain Snow Moisture:
By V. H. Florell 194

Rebuilding Pasture Soils:
By Arnold S. Dahl 196

Book Reviews and Abstracts:
By Phoebe O'Neall Faris 201

For Reference:
Compiled by Mrs. Etta G. Rogers ..... Opposite 202

Soil Conservation is issued monthly by Soil Conservation Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. Soil Conservation seeks to supply to workers and cooperators of the Department of Agriculture engaged in soil conservation activities, information of especial help to them in the performance of their duties, and is issued to them free. Others may obtain copies from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of $1.00 per year, domestic; $1.40 per year, foreign. Postage stamps will not be accepted in payment.

WELLINGTON BRINK
EDITOR

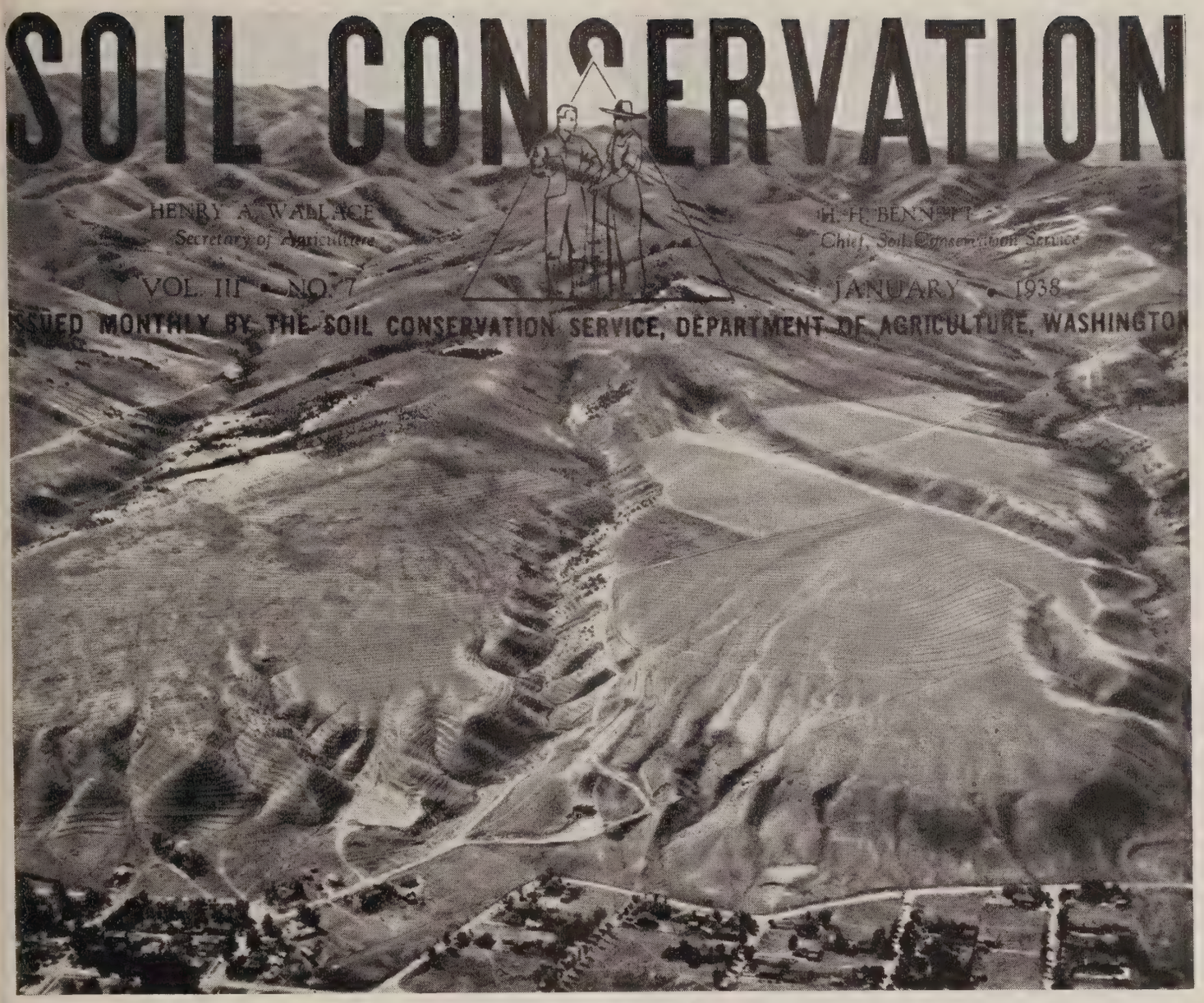
SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

H. H. BENNETT
Chief, Soil Conservation Service

VOL. III • NO. 7 JANUARY • 1938

ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON



Aerial view of terrain adjacent to City of Pocatello, showing slopes protected by contour furrows. (Photo by courtesy of 41st Division, Aviation, Washington National Guard.)

620 Miles of Contour Furrows Stabilize the Pocatello Hillsides

By Glenn M. Querna [1]

IT is now 2 years since soil conservation workers from Camp Bannock, at Pocatello, Idaho, began organizing hillside defenses against flood-causing run-off water on the slopes surrounding the city. Today the results of the project point toward a successful conclusion, with only a few years more work needed to assist nature in establishing soil-holding vegetation.

Weapons employed in the battle are few but effective. Contour furrows, 620 miles of them, constitute the first-line defenses. Water hold-back assists the regrowth and spread of native range vegetation. Torrential rains are put to useful work, rather than being permitted to carry silt and debris down into the city.

THE contour-trench system of flood and erosion control was first developed and used by Reed W. Bailey, director of the Intermountain Forest and Range Experiment Station, on the Davis County watershed in northern Utah.

Contour terracing to save soil and moisture is nearly as old as agriculture itself. Although identical in principle, the practical application of these contour

[1] Section of Information, Soil Conservation Service, Spokane, Wash.

The "Pocatello plow" designed and perfected on the project. Note the hydraulically operated damming attachment at the rear.

Another view of contour furrows above the city of Pocatello.

Contour furrows filled with water after torrential rain of July 31, 1936.

structures to flood and erosion control on high range watersheds in the semiarid West involved a number of changes both in design and methods of construction.

Technicians at the Pocatello camp decided on the construction of contour furrows at intervals and of capacities to hold 50 percent of a 2-inch rain over a 24-hour period. Hand-built furrows proved to be entirely effective in preventing run-off on a small watershed so treated, but their construction was slow and costly. Horse- and tractor-drawn plows, disks, and furrow-builders were tried. Shoes were made for bulldozer blades to hold blade ends in proper trenching

(*Continued on p. 177*)

The Living Soil

Figure 1.—Direct microscopic examination of soil, showing the growth of mold mycelium binding the soil particles.

By Selman A. Waksman [1]

THE upper layer of the earth's crust, namely the soil, in which grow our cultivated and uncultivated crops, does not represent a dead mass of disintegrated residues of rocks intermixed with dead remnants of the numerous plants and animals living in or on the surface of the earth. The upper layer of the soil, while it appears a dead mass, nevertheless furnishes a home for numerous forms of life. As a result of the activities of these organisms, the soil is able to supply food in an available form to the yearly crops of annual and perennial plants grown upon it. For every plant or animal living on the surface of the earth, there are hundreds of kinds of lower forms of life which lead their entire existence within the soil and which give life to the soil itself. These are the microscopic organisms commonly known as microbes, comprising numerous bacteria, molds, yeasts, and yeastlike forms, protozoa, minute worms, and many others. They belong to both the plant and animal kingdoms. They vary considerably in size, ranging from forms large enough to be seen with the naked eye to those that require very powerful microscopes in order to be detected. Their numbers are recorded not on the basis of an acre or even a pound of soil, but per 1 gram of soil, or a small fraction of a pound. The abundance of these organisms in different soils depends upon the nature of the soil, upon the methods of soil treatment and fertilization, nature of crops grown, and a number of other factors, such as reaction, temperature, aeration, moisture supply, and amount of organic matter.

Certain well-defined techniques have been developed for determining the numbers of the various micro-organisms inhabiting the soil and for measuring their activities. It has been established that these numbers vary from several millions to many billions per 1 gram of soil. Although even these large numbers make up in volume only a small part of the actual mass of the soil, they bring about numerous chemical transformations, as a result of which they influence in many ways the growth of the cultivated and uncultivated crops. They also exert certain important physical effects upon the soil. This is especially true of the binding effect upon the soil particles, either through the production of certain slimy substances or through their long and thin cell bodies. They are thus able to bring the soil into a better physical state, and prevent rapid removal of the soil by water. On the other hand, in the case of heavy soils, the various gases produced by these micro-organisms, notably the carbon dioxide, keep the soil in loose friable condition favorable to the cultivator and to the growth of the crop. The soil microbes also assimilate in their bodies large amounts of essential plant nutrients, notably the nitrogen, the phosphorus, and other elements, and thus prevent the rapid leaching out of these elements. The bodies of these micro-organisms later decompose and liberate the nutrients back into circulation; they serve, therefore, as storehouses of plant nutrients in the soil.

THE mere listing of the names of the numerous micro-organisms found in normal soils would require considerable space; it is hardly necessary for the purpose of this discussion. It is sufficient simply to indicate that these microbes can be broadly classified into plant and animal forms. The plant forms are usually further subdivided into those

[1] Microbiologist, N. J. Agricultural Experiment Station, New Brunswick, N. J.

Figure 2.—The growth of another soil organism, an actinomyces, throughout the soil mass, as shown directly by the microscope.

organisms which contain green coloring matter or chlorophyl, namely the blue-green and grass-green algae, and those organisms which do not contain any chlorophyl, namely the fungi and bacteria. The algae function in the soil in a manner similar to higher green plants; they are able to assimilate carbon dioxide and synthesize organic matter, the function of which in increasing the organic matter supply of the soil is still unknown. A few of the algae, found among the blue-green forms, are also capable of fixing atmospheric nitrogen; here as well, the importance of the process in increasing the supply of soil nitrogen is a matter for further study.

The nonchlorophyl bearing microbes have received the greatest attention, since they are the ones that are known to play the most important roles in the chemical soil processes. They bring about the disintegration of the plant stubble and leaves, farm and kitchen wastes, and numerous other plant and animal residues in the soil and in the compost. Gradually these materials are transformed into a dark-colored homogeneous mass known as humus, which imparts to the soil some of its important characteristic properties, and thus distinguishes a soil from a mere mass of fragments of disintegrated rock material. The essential elements stored in the residues are changed, in the process of decomposition, into forms in which they can again be utilized by the growing crop. The carbon is changed to carbon dioxide, the nitrogen to ammonia, the phosphorus to phosphate, etc. The relative proportions of the waste residues that become mineralized or that are changed into humus depend upon their nature and upon the conditions under which decomposition takes place.

In addition to the foregoing processes, these microbes bring about numerous other chemical changes in the soil which are essential for rendering the soil fertile and permitting the growth of a normal crop. Some bacteria are able to fix nitrogen, thus increasing the store of the combined nitrogen in the soil. Certain organisms are able to carry out this process independent of higher plants, that is in the soil itself, and are thus known as nonsymbiotic organisms; other bacteria fix atmospheric nitrogen only when they live within the root systems of certain higher plants, mostly belonging to the Leguminosae, and are thus known as symbiotic organisms. The exact mechanism of these two processes is still a matter for further study; they are of the greatest importance in soil fertility. Still other microbes are capable of oxidizing various elements or compounds in the soil, such as ammonia to nitrate, sulphur to sulphate, thus affecting the availability of these important elements for plant growth.

The animal population of the soil also comprises a great variety of forms ranging from the numerous microscopic protozoa to the large earthworms. The major function of these organisms consists in working over of the soil, mixing the organic and inorganic contituents, thus improving the physical texture of the soil. These animal forms also exert, through their activities, various effects upon the crop; these may be either beneficial or injurious in the economy of the soil. It is sufficient to mention, in addition to the physical effects, the ability of many animal forms, notably the protozoa, to decompose various plant and animal residues; they are thus able to function in a manner similar to the bacteria and the fungi. On the other hand, some forms attack the root systems of higher plants and produce various diseases, such as the

root galls and the root knots caused by nematodes. Various plant-destroying insects, such as the Japanese beetle and others, pass a part of their life cycle in the soil and may thus be considered as soil forms.

As a result of their activities in the soil, the microorganisms are responsible for numerous chemical changes which affect the growth of crops in many ways: 1. They take part, either directly or indirectly, in the processes of weathering and in the formation of the different soil types. 2. They reduce the tremendous waste of plant and animal life and transform these residues into humus, which becomes an essential and important part of the soil system and which exerts highly favorable effects upon crop growth. 3. They change the essential plant nutritive elements in the soil into a condition in which they can again be utilized by the crop. 4. They improve, directly or indirectly, the physical condition of the soil, so as to render it a favorable medium for the growth and nutrition of the root systems of higher plants. 5. They destroy various injurious substances formed in the soil, which would otherwise affect detrimentally the growth of the crops. 6. They antagonize and keep in a certain check the development of various injurious bacteria, fungi, and nematodes which would otherwise destroy the crops completely. These soil microbes may thus be truly considered as the greatest friends that man has on this earth. They form the true connecting link between the living and dead worlds, between the organic and inorganic worlds. Without them life would soon come to a standstill. It is as a result of their continuous activities that life of plants and animals is made possible on this planet, that waste products can again be transformed into living products of the plant and animal worlds.

Among the characteristics which distinguish a rich soil from a poor one, a fertile soil from an infertile one, are, primarily, the abundance of organic matter, the availability of the nutrient elements in the soil, and the activities of its microbiological population. The latter may thus be considered as a true index of the fertility state of the soil. One can easily measure, by certain laboratory procedures, the rate of availability of the nitrogen in the soil, of the phosphorus and the potassium, the rate of decomposition of the soil humus, etc.

In addition to the favorable organisms, however, the soil also harbors certain injurious microbes which cause different plant diseases, as in the case of the fungi that cause the damping-off of nursery stock and of numerous vegetable crops, of the scab disease of potatoes and sugar beets, of the take-all disease of cereal plants, of a great variety of root rots, root galls and other diseases.

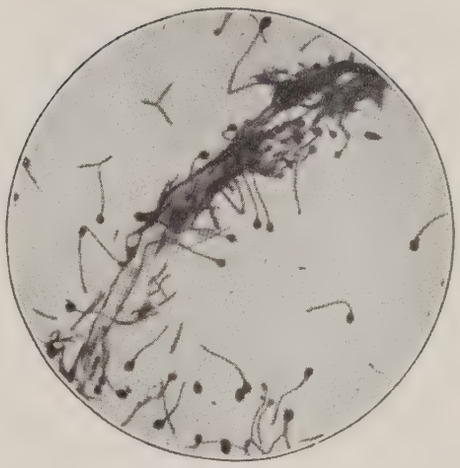


Figure 3.—Attachment of bacteria to a particle of organic matter which they are destroying. Highly magnified.

Certain disease-producing organisms of animals and man may also be harbored and even lead a normal existence in the soil. It is sufficient to mention the botulinus organism, the tetanus bacillus, the gas-gangrene producing bacteria, the organism that causes lumpy jaw of cattle, hookworm larvae and the larvae of numerous insects, in order to appreciate their possible significance. Although our present methods of control of these disease-producing organisms depend upon physical and chemical soil treatments, crop rotations, and selection of immune varieties, it is now becoming more and more recognized that these injurious organisms are largely kept in check in the soil through the activities of the normal soil microbes. The various common soil fungi and bacteria have been shown to be able to exert decided protective effects

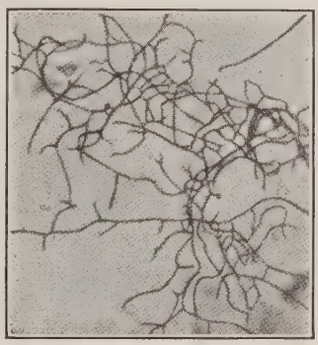


Figure 4.—Strands of a typical soil organism, an actinomyces, removed from the soil. Highly magnified.

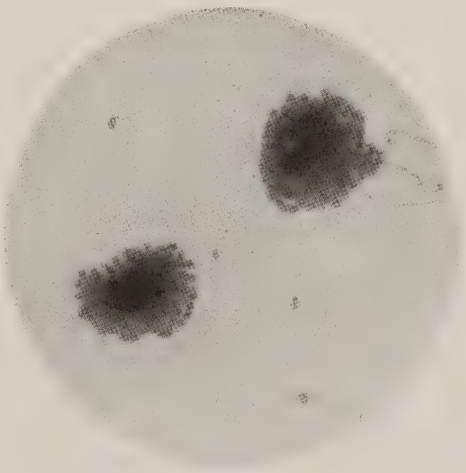


Figure 5.—The growth of bacteria in soil in the form of colonies, as determined by special methods. Highly magnified.

against the rapid spread of disease-producing organisms which would otherwise cause complete destruction of cultivated crops.

The question often arises whether it will ever become possible or advisable to introduce micro-organisms into the soil to hasten processes which are already taking place in the soil, to bring about new processes, or to help keep in check certain disease-forming organisms. One must state emphatically that, with certain very few exceptions, the introduction of beneficial organisms into the soil has not progressed beyond the use of legume cultures. While there is no doubt that a few organisms may at times be profitably introduced into the soil, either because of their absence in certain soil formations or because they may be present in a weakened state, as in the case of certain mycorrhiza fungi for forest nursery stock, the indiscriminate use of all-crop inoculants should be condemned. In most cases an improvement in the microbiological condition of the soil will follow the correction of the physical and chemical soil conditions, as upon the addition of lime to acid soils, of organic matter to depleted soils, upon proper aeration of poorly drained soils, etc. In the use of sulphur for the correction of alkalinity of the black-alkali soils or increasing the acidity of potato soil, to prevent scab development, certain specific bacteria were found to play an important role; whether the introduction of special cultures of these bacteria for inoculation purposes is justified or not, the fact remains that the oxidation of the sulphur is brought about largely through the action of these bacteria, the presence of which in soil is highly essential.

One may ask further, What role do all these micro-organisms play in the conservation of the fertility of the soil? What part do they play in preventing the losses of the soil itself? These losses are usually brought about in three distinct ways, namely as (1) gaseous losses, notably the soil nitrogen; (2) losses in a liquid state, through the constant dissolution of some of the plant nutrients by the movement of the water in the soil; and (3) losses in a solid state, or true soil erosion. It has been amply demonstrated that the problems of water and wind erosion, as well as soil deterioration due to improper systems of cultivation, are closely associated with the problem of soil organic matter. A decrease in the organic matter content accompanies soil deterioration and is in itself a cause for further deterioration, while an increase in organic matter and nitrogen is a symbol of soil improvement. Micro-organisms are closely associated both with the formation and with the destruction of the organic matter, and with an increase or a decrease of the available nitrogen. Any systems of permanent soil improvement or soil conservation must, therefore, consider the influence of soil treatment upon the activities of the soil-inhabiting micro-organisms, as well as the methods of utilizing their activities in order to bring about a permanent system of agriculture. One must further consider the fact that soil erosion results in the loss of the active or living surface layer of the soil, leaving the dead subsoil. The latter, because of lack of aeration and of sufficient nutrients, limits the growth of the important soil micro-organisms.

Another important soil phenomenon may be classed under the group of processes leading to soil deterioration, namely, the formation of sick or exhausted soils. In many cases, this is due to the accumulation of fungi, bacteria, protozoa, nematodes, and larvae parasitic either upon higher plants or upon the normal microbiological population. In other instances, it is due to the formation of toxic substances, the nature of which is not fully established, which are injurious to plant growth, in one way or another. Some of these deficiencies can be corrected by treatment of soil with steam or certain chemicals (partial sterilization); others are corrected by the introduction of specific mineral elements not commonly employed in fertilizer mixtures, such as copper, manganese, and zinc; still other conditions can be prevented or corrected by proper systems of crop rotation and soil improvement. One is dealing here with a group of important soil relationships, the nature of which is still incompletely understood, although considerable knowledge has already accumulated and various methods (palliative, to be true) have been developed for correcting the deficiencies. Soil conservation must keep a proper balance of the microbiological population of the soil and a proper state of microbiological efficiency. Attention may also be called here to the recent investigation on the phenomenon of soil fatigue caused by the accumulation of bacteriophage in old alfalfa and clover soils. This results in the destruction of the specific bacteria concerned in the formation of nodules, thus leading to reduced nitrogen fixation. The plants behave under these conditions as nonlegumes. Different plants and different varieties of the bacteria producing the nodules are not sensitive alike to the bacteriophage, which thus suggests methods for overcoming this soil condition.

In addition to preventing and combating soil losses, micro-organisms can also be made, with proper systems of crop rotation and soil management, to increase the fertility of the soil; they are thus able to replace at

least some of the nutrients lost from the soil. It is sufficient to mention here the use of stable manures, composts and green manures. These serve several distinct purposes in the soil: (1) They conserve the plant nutrients from being leached out; (2) they render the nitrogen available for the following crop; (3) they add organic matter to the soil; (4) they increase the supply of nitrogen in the soil through judicious utilization of leguminous crops.

The micro-organisms of the soil must be managed and their activities controlled; they must be domesticated, just as are cultivated crops and domestic animals. Although only very few microbes—such as the legume bacteria, certain sulphur bacteria, some mycorrhiza fungi, and some of the nitrifying bacteria—have so far been domesticated, the future holds forth promise of utilization of many other lower forms of life, and this will enable man to control at will the various soil processes which affect the growth of his crops and his animals. Only then will man take full advantage of the soil microbes as agents to help him in the conservation of the tremendous wealth that nature has stored in the soil. [2]

[2] Further information on the subject discussed in this article can be obtained from Dr. Waksman's book, Principles of Soil Microbiology, from which most of the accompanying illustrations are taken.

Figure 6.—Bacteria from nodules on the roots of a leguminous plant (soy bean).

620 MILES OF CONTOUR FURROWS

(*Continued from p. 172*)

position. Drawbacks of these methods were generally a nonuniform trench, requiring extensive hand finishing and excessive cost.

Solution of the problem came with the perfecting, on the project, of a contour-furrow builder that does the work of a hundred men. A heavy 22-inch brush-breaker plow, pulled by a track-type tractor, scoops out a 12-inch deep furrow. The machine has a special damming attachment, operated hydraulically from the seat of the tractor, which allows the furrows and dams to be completed in one trip. Dams, placed at intervals of 12 to 50 feet, prevent concentration of water at low places and result in a more even distribution of moisture, in addition to permitting slight deviations from the contour.

With contour furrows covering at the present time more than 2,000 acres of sloping land adjacent to Pocatello and aided in their water utilization work by extensive systems of waterspreading ditches emanating from gully dams, the next step consists of the planting of the disturbed earth to adapted grasses. Vigorous growths on these planting sites where moisture is plentiful have already proved their ability to spread and cover the areas between furrows. Necessary to the success of the revegetation program, grazing has been completely restricted from the area for the duration of the 5-year cooperative agreements.

Citizens of Pocatello realized, through annually recurring depositions of silt, sand, and debris following seasonal cloudbursts peculiar to the areas surrounding the city, the necessity of permanent control measures. Civic cooperation has done much to facilitate the work of the Service. Mindful of the harm that has been done through cutting of juniper stands for firewood, and destruction of the remaining forage by huge flocks of sheep on their way to high ranges and back to market, civic and county authorities virtually have turned the critical areas over to the Service. Control of the problem, to them, has meant property insurance.

Control is simple and straightforward. A series of level pockets catches the run-off from the slopes and hold it until it soaks into the ground. More vegetation grows where more moisture is available. More vegetation will check more runoff. Providing against the ever-existent flash-rain contingency, the contour furrows will continue their usefulness long after sufficient vegetation in the form of grass, shrubs, and trees has grown to pin down the soil and hold rain water.

Camp Bannock's tree-planting program has a threefold purpose: First, to stabilize the contour furrows;

(*Continued on p. 202*)

The Beaver as an Upstream Engineer

Sheep grazing on an ancient beaver meadow.

By Paul M. Scheffer [1]

FROM time immemorial the beaver has been America's number one conservationist. Even today he is a foremost wildlife citizen—and a decidedly useful one at that. His successful efforts in soil reclamation, reforestation, hydraulic and agricultural engineering, agronomy, and water conservation antedate the work of the Soil Conservation Service by more than a million years.

Many thousands of years before the landing of Columbus on the shores of this continent the beaver was doing his bit toward building the land for present-day agriculture. His dams in the streams created countless numbers of ponds over most of the United States and Canada. The waters were intentionally impounded to serve as protective moats for the beaver homes. The dams served also to stabilize the flow of the streams by reducing the force of the water and the crest of floods. The beaver was the original upstream engineer.

In the course of time the old beaver ponds were silted to the brim. Arable meadows were formed, and the succession of plant life which followed made the beaver the pioneer agronomist. Moreover, his work assisted the forester, as well. Many of the swamps created by the beaver grew up to dense stands of shimmering aspen, cottonwood, birch, and willow, and these deciduous lanes along the bottoms of the valleys proved effective in the protection of coniferous stands on the slopes above.

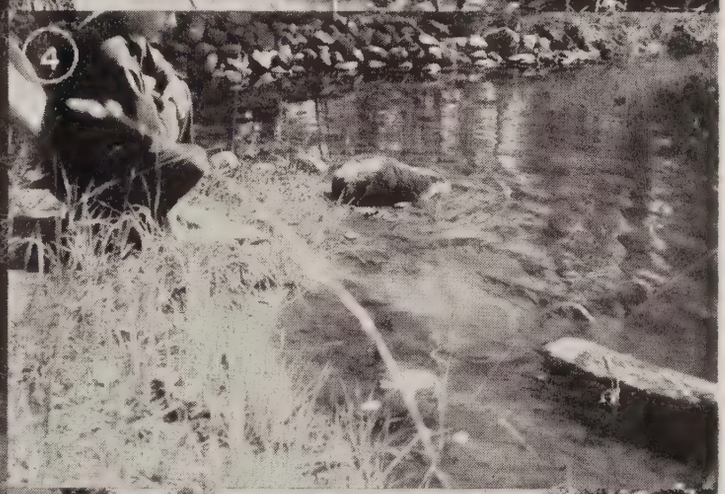
With the cycle of formation of fertile valleys and deciduous forests nearly complete, the old patriarchs and the young beavers moved to sites where the water ran unchecked. Here they built their homes and began the cycle anew.

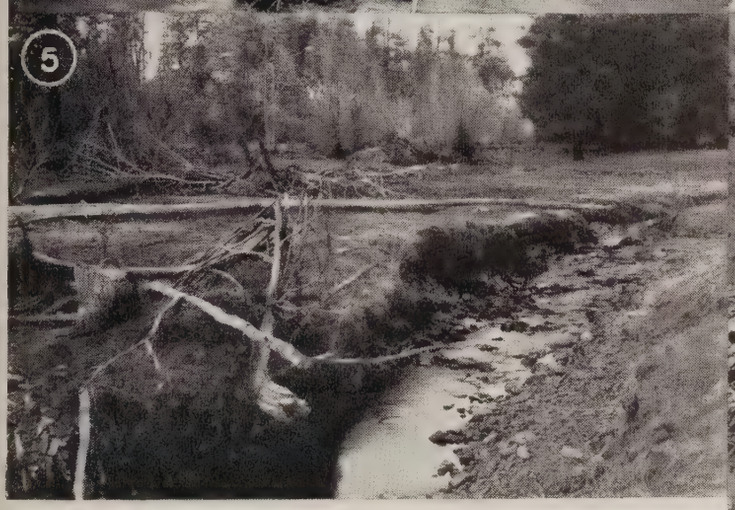
This story is told to introduce the beaver, by way of giving the history of his importance in American agriculture. It also indicates why the beaver was enlisted as an ally of the Soil Conservation Service in its soil- and water-conservation program. Proof of the value of the beaver in a present-day program of this kind is easily obtained, as is attested by definite figures from recent investigations carried on by the wildlife management section of the Service.

The Mission Creek Camp near Cashmere, Wash., was established by the Service for flood-control work.

(*Continued on p. 180*)

[1] Junior biologist, Soil Conservation Service, Badger Pocket Area, Wash.





1. *Dam built by beaver recently re-established by government in ancient beaver meadow. The beavers were transplanted to stabilize the stream and prevent further erosion. (Courtesy Bureau of Biological Survey.)*

2. *Beaver pond completely silted in. Note man standing on accumulated silt.*

3. *Two beaver dams in a series of 22 that have caught 5,844 cubic yards of silt. The water is only 2 inches deep, the silt 4 feet deep.*

4. *Releasing beavers in a high mountain stream on the Ahtanum Creek project.*

5. *Stream erosion along site of former beaver colony. Sequence: (a) beaver trapped 10 years previously, (b) dams washed out by floods, (c) ponds disappeared, (d) new channel cut through meadow by stream. (Courtesy Buraeu of Biological Survey.)*

6. *Typical beaver dam and pond.*

7. *Pond with storage capacity of 5 acre-feet. Some beaver ponds have a capacity of several hundred acre-feet each.*

(Continued from p. 178)

Overgrazing and logging had produced a situation in the upper drainage basin which allowed heavy run-off of water resulting in serious floods in the valley below. Many blocks of valuable orchard trees were washed out, and acres of other orchard land were covered with rocks, soil, and debris.

In 1935 it was discovered that a few beavers in the upper waters of Mission Creek were doing effective work in the control of soil and water losses. Through the Washington State Game Department, 12 more beavers were secured by the Service and added to the colony. These were vagrant beavers trapped from sloughs along the Wenatchee River, 20 miles away. In 1937 a survey was made to determine what work had been accomplished. It was found that where the beavers had formerly occupied only a few hundred feet of stream there were now approximately 60 dams in more than 5 miles of the waterway. Most of the ponds were silted full with the fine sandy soil of the area. At some points the stream bed had been widened from a few feet to more than a hundred feet.

One section of Mission Creek was chosen for a detailed study of the beaver work. This stretch was 2,040 feet long, with a total drop of 50 feet. It contained 22 beaver dams, avera g 42.86 feet in length and 2.84 feet in height—a total length of 943 feet and a total height of 62.6 feet. Five thousand eight hundred forty-four cubic yards of silt had been caught behind the dams; and during the low summer flow of the stream 1.44 acre-feet of water were being stored in the ponds. In the table may be found complete information on each dam.

Measurements of beaver dams, and erosion and flood-control value, in the lower 2,000 feet of the East Branch of Mission Creek

Number of dam	Distance downstream from first dam	Size of dam		Cubic yards of silt behind dam	Gallons of water stored behind dams
		Length	Height		
	Feet	*Feet*	*Feet*	*Cubic yards*	*Gallons*
1	0	15	2	205.5	.....
2	70	16	2	62.5	.....
3	193	60	3.5	439.6	.....
4	323	15	1	72.5	.....
5	475	12	1.5	44.4	.....
6	516	25	3.5	57.5	.....
7	605	52	5	408.7	.....
8	637	32	3.5	706.6	.....
9	920	30	4	185.2	.....
10	1,030	28	3.5	169.1	.....
11	1,120	27	4.6	205	.....
12	1,200	55	4	392.8	.....
13	1,316	67	4.5	76.7	.....
14	1,403	33	3	255	.....
15	1,435	28	1	48.3	.....
16	1,450	25	1	20.3	.....
17	1,573	110	2	694.5	.....
18	1,650	90	3	455.6	.....
19	1,735	120	1	291.2	.....
20	1,780	68	2	173.3	.....
21	1,835	18	3	40.8	.....
22	2,040	8	4	121.6	.....
Total	2,040	943	62.6	5,844.2	[1] 471,675

[1] 1.44 acre-feet.

In 1935 the Service established a camp in the Ahtanum Creek drainage basin near Yakima, Wash., for the purpose of demonstrating water conservation work on about 45,000 acres of land.

The water of Ahtanum Creek is used to irrigate a large agricultural area west of Yakima. Typical of all mountain streams, the Ahtanum varies in its flow with the seasons of the year. During the spring run-off, the stream reaches near-flood proportions and occasionally causes damage. A good flow of water is maintained until July after which the flow rapidly decreases. Through the latter part of July, and in August and September, there is not sufficient water in the stream for irrigation purposes and the crops suffer accordingly.

In order to remedy this condition the Service, besides putting into effect a well-managed grazing and forestry program, has constructed at great expense severa large water-impounding dams on the small intermittent side drainages of Ahtanum Creek. These ponds fill up during the heavy spring run-off and store thousands of gallons of water that would otherwise be lost. Later in the summer when the water is needed in the valley below, the ponds slowly drain into the streams.

With the conviction that beavers could be o material assistance in the program the Service in 1936 obtained 10 of the animals from the Washington State Game Department and transplanted them from the irrigation ditches of the lower Yakima Valley orchard district to the Ahtanum Creek area, 60 miles away. In their new homes on the project the beavers constructed several large dams, one of which in particular is worthy of note in that it is doing effective work in the storage of water in the upper drainage area. In June 1937 the dam was 90 feet long, 7 feet high, and was blocking a stream flowing 65 second-feet of water. The storage capacity behind the dam was 691,500 gallons or 2.11 acre-feet. The dam was again observed 3 months later and was found to have been extended several rods and raised an additional 3 feet. The water storage at this time was estimated to be 5 acre-feet. Our engineers tell us that a man-made dam similar to the one just described would cost $2,500. The beaver dam cost almost nothing.

Encouraged by the success of the 1936 planting, a survey to appraise facilities for beavers was made a year later. The availability of the principal food trees (aspen, cottonwood, and willow) along all streams was

determined. The potential number of beavers that the streams could support was then worked out and a transplanting program was planned. The program planned calls for the moving of 50 to 60 beavers into the area within 3 years.

In the fall of 1937, 22 beavers were trapped from irrigation ditches near Cle Elum, Wash., where they had been causing the farmers considerable trouble by blocking irrigation systems and flooding fields. The beavers were taken to the Ahtanum Creek camp 100 miles away and turned loose at various sites selected in the headwaters of the area. As far as can be determined at the time all of the transplanted beavers are in the vicinity of the original planting sites, and they have started construction work on several dams.

It is interesting here to point out the low cost of water storage by beavers: It is estimated that within a 10-year period after the completion of the beaver transplanting program in this Ahtanum Creek area costing $500, the beavers will have constructed enough ponds to have a total water-storage capacity of 500 acre-feet, or $1 per acre-foot. And this is only a beginning as far as the beavers are concerned.

It is not implied here that beaver transplanting and management should supplant other programs designed to conserve soil and water on the Ahtanum Creek camp, Mission Creek camp, or any other area. It is suggested, however, that on those projects where stream stabilization is necessary for soil and water conservation, a program in which beavers are utilized to supplement other control measures should be initiated. If this is done, more efficient and certainly less costly results will be obtained.

Much work is yet to be done before the management of beavers can be completely successful. The biggest problem is the working out of methods to induce the animals to remain at the transplanting sites and to prevent them from wandering off to plug up some irrigation system or cut down choice apple trees. However, if the proposed planting sites are carefully studied and planned, the transplanting of beavers should be as simple and satisfactory as the moving of fish from one stream to another.

Thus we see that proper management of the beaver—original upstream engineer, agronomist, and forester—will make available to us many benefits in effective soil and water conservation. We are indebted to the beaver for what he has done; let us give him every opportunity to continue his work.

Seeding Mixtures

In examining the results obtained from the use of recommended seeding mixtures of commercial grasses and legumes on numerous projects throughout the country, I have concluded that the matter of mixtures is still an open question. I am of the opinion that in many cases such mixtures are not the result of actual experimental work but that they have been built up theoretically. I recommend that the agronomists on the projects and in the camps make an attempt to study the results obtained from seeding mixtures and use this information, after contacting the State experiment stations, as the basis of future recommendations. Such observations should be made carefully, as often the failure of any particular grass or legume may be due to poor seed or poor seeding conditions.—C. R. E.

Domestic Ryegrass

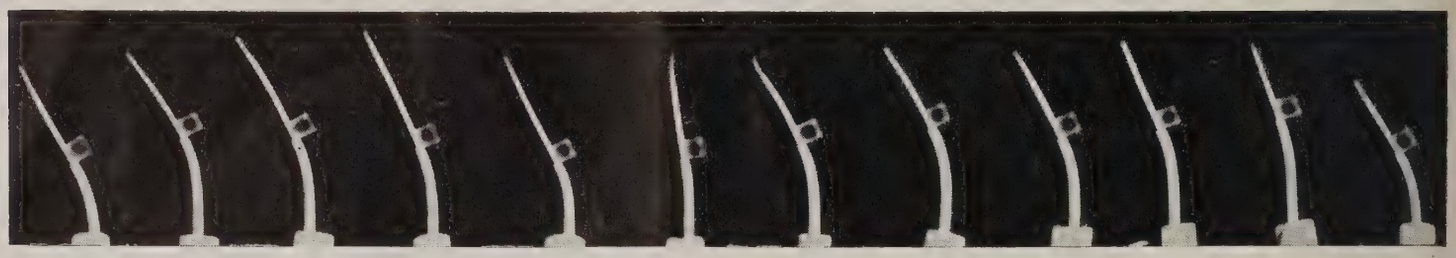
Domestic ryegrass occupies extensive areas of poorly drained land in the Willamette River Valley of western Oregon. These areas are harvested for seed, and sometimes sufficient seed remains on the land to reseed it.

This grass offers excellent fall, spring, and even winter grazing on rather poorly drained soils in our Southern States. In many localities, such as Oklahoma, the livestock can be removed from the grass in time to allow it to reseed. There are many thousands of acres of such lands now lying idle which might be utilized for pasture, thus relieving the burden on other pastures or allowing badly eroded grasslands to be retired to woods.—C. R. E.

Terrace Outlets and Meadow Strips

Throughout the soil conservation projects, there has been a distinct tendency, during the past year or more, to locate terrace outlets in natural depressions rather than to construct these outlets artificially. This tendency should be encouraged, as natural depressions are much more satisfactory for the production of vegetation. Certainly, artificially constructed terrace outlets or meadow strips should be given a very liberal application of manure and commercial fertilizer if vigorous vegetative growth is to be expected. Frequently it is necessary to establish meadow strips or terrace outlets hurriedly in order to take care of the water from the terraces. A mulch of manure or other material, spread over the seeding, will invariably assist in securing a better stand and heavier growth. In critical locations, the mulch can be tied down with chicken wire. Certainly, such a method of establishing grass is much more economical than sodding, and farmers are willing to employ such practices. Usually farmers cannot afford to sod waterways or terrace outlets.—C. R. E.

Curvature of oat coleoptile following application of agar block containing 4.10^{-7} mg. of indole-3-acetic acid.



Curvature of oat coleoptile following application of agar block containing 8.10^{-7} mg. of indole-3-acetic acid (heteroauxin). (After Van Overbeek.)

Synthetic Growth Substances, a New Development

By V. T. Stoutemyer [1]

ONE of the serious obstacles in the production in large quantities of the most desirable plants for soil conservation purposes is the much greater expense and difficulty of vegetation propagation as compared with the starting of plants from seed. The advantage of securing products of economic value from plants used to check erosion needs no emphasis. The use of superior varieties or selected plant strains is highly beneficial in many instances, to improve both the erosion control and the economic qualities of these plants, and this necessitates vegetative propagation. Unfortunately, vegetative methods often are too costly for production on a large scale, and the use of seedlings is the only alternative. In the field of forestry the same difficulty has discouraged hybridization and selection of superior varieties of forest trees, except with a few kinds such as the poplars which may be propagated very easily by means of hardwood cuttings. The shipmast locust [2 3 4 5] is an example of clearly demonstrable superiority of a selected variety over seedlings. Many other similar illustrations could be cited, pointing out plants of all kinds.

IT is hoped that the recent developments in the use of plant hormones or synthetic growth substances will assist in solving this problem. Any predictions as to the extent to which these materials may be adapted in the future, or the value they will have in propagating exceptionally difficult subjects, are quite unsafe. The new technique in propagation is now being employed, however, by practical propagators in commercial greenhouse and nursery establishments.

From a purely scientific point of view, the recent discoveries regarding growth substances in plants constitute an exceedingly important development in the field of plant physiology. Although the subject has come into prominence only recently, it is not entirely new; the existence of plant hormones was suggested on a largely speculative basis, by the botanist Sachs as long ago as 1882. Most of the early knowledge of plant hormones was developed during the earlier part of the present century by a number of European botanists, including Fitting, Boysen Jensen, Paal, Söding, and Went. Only recently experimentation was started by a few American research centers, notably the Boyce Thompson Institute for Plant Research, the California Institute of Technology and the Division of Fruit and Vegetable Crops and Diseases of the Bureau of Plant Industry of the United States Department of Agriculture. Some of the greatest advances have been made at these institutions.

As a basis for the study of plant hormones, almost all of the early workers concentrated on the end of a shoot

---

[1] Assistant Horticulturist, U. S. Plant Introduction Garden, Bureau of Plant Industry, U. S. Department of Agriculture, Glen Dale, Md.

[2] Morrison, B. Y. A new variety of black locust. Science 82: 326–327. 1935.

[3] Raber, O. Shipmast locust, a valuable undescribed variety of *Robinia pseudoacacia*. U. S. Dept. Agr. Circ. 379. 1936.

[4] Detwiler, S. B. The history of shipmast locust. Journal of Forestry 35: 709–712. 1937.

[5] Hall, R. C. Growth and yield in shipmast locust on Long Island and its relative resistance to locust borer injury. Journal of Forestry 35: 721–727. 1937.

(coleoptile) of a young oat seedling grown in the dark. Even now, the oat plant, *Avena sativa*, is much used for detecting the presence and estimating the activity of small quantities of plant hormones. This large use of a standard subject for experimentation is very fortunate as it enables workers in all parts of the world to compare results.

The response of the coleoptile to light was the first reaction studied. The coleoptile of a young oat plant which has been grown in the dark will bend toward the light upon exposure. The curvature is caused by the action of a plant hormone formed at the tip which stimulates growth on one side of the coleoptile. Agar blocks containing minute quantities of the hormone, placed on the coleoptile, will cause the same responses, even if the tip is removed. Similar effects may be obtained by the use of a number of chemicals prepared synthetically or extracted from certain plant and animal products. The degree of curvature in the coleoptile is related to the amount of hormone present, which makes possible one of the methods of quantitative determination. The relative curvatures of oat colepotiles caused by two different concentrations of indole-3-acetic acid (heteroauxin) are shown in figures 1–a and 1–b.

An important advance was made when European chemists including Kögl, Haagen, Smit, and Erxleben showed the composition and structure of those substances extracted from urine and from various animal and plant products which caused the typical hormone-like responses on the oat coleoptile. The rapid development which occurred is summarized in Boysen Jensen's [6] book which appeared in an American edition in 1936.

[6] Boysen Jensen, P. Growth hormones in plants. Authorized translation and edition by G. S. Avery, Jr., P. R. Burkholder, H. B. Creighton, and B. A. Scheer. New York. 1936.

Lemon cuttings treated at the base with tap water for 8 hours. Root development after 2½ weeks.

Lemon cuttings treated at the base with heteroauxin (0.5 mg. per cc. of water) for 8 hours. Root development after 2½ weeks. (After Cooper.)

Hormones have been shown to play a definite role in many of the life processes of plants, beginning with seeds, where they apparently play a part in germination and the growth of the seedling. They are essential for the shoot growth of higher plants and they regulate cell division and enlargement, although in a manner not understood at present. They may start bud growth or cambial activity, but they can also inhibit growth in other places in a plant simultaneously. Phytohormones may start the formation of tumors and intumescences on plants and initiate the production of roots on stems. It is known also that these substances control some of the movements of plants in response to light and gravitation. Hormones are probably connected with the process of seed production in plants, and already the existence of substances which cause flowering in certain plants has been claimed. The application of some of the synthetic growth substances to flowers has caused the production of parthenocarpic fruit, or in other words, fruit which has been produced without fertilization and which does not contain viable seed.

The spectacular aspects of the subject have furnished welcome material to writers for the newspapers and popular magazines. Some of this publicity has been regretted by serious scientists. In some instances, worthless materials have been sold to the public as root forming hormones.

While the nomenclature of the subject is still unstandardized, all authors try to draw a distinction between the hormones which are believed to exist in living plants and the numerous synthetic chemicals which cause similar hormone-like responses in plants. The latter group of substances is designated by terms such as growth promoting substances, synthetic growth substances, or root forming substances. They cannot properly be called plant hormones.

Which are the true hormones? This is not known definitely, although three substances of known composition have been suggested as occurring in higher plants. These are:

Auxin a ($C_{18}H_{32}O_5$) Auxentriolic acid
Auxin b ($C_{18}H_{30}O_4$) Auxenolonic acid
Heteroauxin ($C_{10}H_9O_2N$) Indole-3-acetic acid

These three substances have been found in fungi; and although they have been reported to occur in higher plants, this has been contradicted. The exceedingly minute quantities of hormones present in plants make chemical determinations a difficult problem, even though their high potency allows a quite simple demonstration of their presence. Both auxin a and heteroauxin may be obtained from human urine. Heteroauxin may be extracted from certain molds and yeasts. Auxin b has been prepared from plant oils and malt.

Growth promoting substances at present have practical applications as aids to root formation in stem cuttings of plants. The reports of several investigators in recent years have suggested that root formation in cuttings is initiated by a hormone present in the buds and leaves of plants. This was designated by Bouillenne and Went [7] as "rhizocaline." Workers at the Boyce Thompson Institute for Plant Research [8 9 10 11 12] made the important discovery that identical responses in root formation could be secured by using various gases, organic acids, and esters. They have now discovered approximately 50 compounds which will initiate root formation on stems. The mechanism by which exceedingly minute quantities of these compounds cause root formation on stems is not known. Indolebutyric acid, indoleacetic acid, phenylacetic acid, indolepropionic acid and napthaleneacetic acid are the compounds which have been most commonly used for root stimulation. Indolebutyric acid has proved especially effective with a wide variety of plants. These substances are crystalline compounds and are used in very dilute aqueous solutions. The crystals are first dissolved in a small quantity of alcohol and the water is then added to give the required dilution. No general rules may be given for the amount of dilution since the most favorable concentrations vary with the particular species of plant. As a rule, the solutions vary from 20 to 50 milligrams per liter of water. Even lower concentrations are used for succulent herbaceous cuttings, while the higher concentrations are needed for a more woody type of cutting. The time of treatment varies with the different species and may vary from an hour to three days. As a rule, the woody plants require the longer treatments. Overtreatments, by using either a too strong solution or for too long a time, is quite injurious to the cuttings. Some information for the treatment of different species of plants is now available, but much more experimental work will be necessary to determine the best treatments for different plants.

The treatments are applied by making the cuttings in the conventional way and then placing the cut basal ends in containers of the solution in such manner that the transpiration of the cuttings will cause the solution to be taken up. The cuttings are treated under ordinary room conditions. The full light of the sun should be kept from the cuttings during treatment. At the end of the time required for the particular species of plant, the cuttings are removed and the solution is washed from their bases. The cuttings are placed in the ordinary propagating structures and care is given exactly as with ordinary untreated cuttings. An illustration of the effectiveness of these substances in stimulating rapid root formation is shown in figure 2.

This illustration shows the quick and abundant root formation in lemon cuttings following treatment with heteroauxin in an experiment by Cooper.[13] A clue to the manner in which growth substances act to induce root formation is given in the same report. Cooper's results indicated that the substance acts indirectly by causing the rapid movement of "rhizocaline" from the buds and leaves at the top of the cutting to the base. When the lower ends of the stems of treated cuttings were cut off, little stimulation occurred. This supported the theory that the removal of the lower ends of the cuttings also removed the accumulated rhizocaline at the base. After this was done, further treatment of the cutting with a solution of growth substance presumably was futile since the rhizocaline in the cutting was depleted.

Undue enthusiasm concerning the value of the growth

(*Continued on p. 189*)

[7] Bouillenne, R., and F. Went. Recherches expérimentales sur la néoformation des racines dans les plantules et les boutures des plantes supérieures (Substances formatrices des racines). Ann. Jard. Bot. Buitenzorg 43: 25–202. 1933.

[8] Zimmerman, P. W., and A. E. Hitchcock. Initiation and stimulation of adventitious roots caused by unsaturated hydrocarbon gases. Contrib. Boyce Thompson Inst. Plant Res. 5: 351–369. 1933.

[9] Zimmerman, P. W., and F. Wilcoxon. Several chemical growth substances which cause initiation of roots and other responses in plants. Contrib. Boyce Thompson Inst. Plant Res. 7: 209–229. 1935.

[10] Zimmerman, P. W., and A. E. Hitchcock. The response of roots to "root-forming" substances. Contrib. Boyce Thompson Inst. Plant Res. 7: 439–445. 1935.

[11] Hitchcock, A. E., and P. W. Zimmerman. Effect of growth substances on the rooting response of cuttings. Contrib. Boyce Thompson Inst. Plant Res. 8: 63–79 1936.

[12] Zimmerman, P. W., A. E. Hitchcock, and F. Wilcoxon. Several esters as plant harmones. Contrib. Boyce Thompson Inst. Plant Res. 8: 105–112. 1936.

[13] Cooper, W. C. Transport of root-forming hormone in woody cuttings. Plant Phys. 11: 779–793. 1936.

Agronomic Briefs

By C. R. Enlow [1]

Crop Rotations

This is a subject that should be given very serious consideration. How did our present rotations originate, and are they adequate to improve organic matter in the soil? Is it not true that rotations in general have been made to fit a scheme whereby farmers can continue to produce cash crops or crops of immediate cash return? Ordinarily, legumes are recommended in crop rotation systems mainly because an immediate increase in yields of cash crops may be expected.

What about grass in the rotation? Isn't it true, also, that a large supply of carbonaceous material in the soil is necessary actually to increase the organic content to such an extent and in such a way that it will remain there for a considerable period?

During a recent trip through France, I observed that most French farmers are following a rotation of root crops, small grain, and legumes, on approximately half of the farm while the other half is in permanent grass or legume-grass hay, or in pasture. After several years, the grassland is plowed for cropping while the cropped portion of the farm is seeded to grass. This system, coupled with proper management of grassland, the use of lime and phosphate, and the addition of manure, has resulted in a very high acre yield.

On soils very low in organic matter, the addition of a large quantity of carbonaceous material, such as grass, straw, or weeds, frequently reduces the crop yield for the next year. The reason for this is that the bacteria are using up available nitrates in the soil in breaking down the straw. It appears that if we are to use good judgment, such a program should be followed, with modifications, in this country, so that eventually we may achieve some actual improvement in the organic content of the soil and make it more productive. Legume-grass mixtures are perhaps the solution to the immediate problem, and it is recommended here that these be used wherever possible instead of straight legume seedings.

Contour Furrows

The use of contour furrows is justified by (1) the conservation of moisture to obtain a better vegetative cover, and (2) immediate erosion control necessary to ensure sufficient stabilization of the soil so that vegetation may come back naturally or from seeding. Moisture conservation is the primary objective in semiarid regions, while immediate erosion control is the main object in regions of higher rainfall. Furrows should be so arranged that considerable water will be held on the land in a form to be utilized by a large percentage of the vegetation. Certainly, if the grass is managed in such a way that the roots penetrate deeply into the soil and the cover of leaves and stems protects the soil from high temperature, evaporation will be reduced and the extra moisture will be of value during periods of drought.

Strip Cropping

Strip cropping in many modified forms is now covering approximately 1,000,000 acres in this country. There have been so many deviations from the general plan, principally to meet the farmers' objections, that it is doubtful in some cases if any worth-while results will be secured. Frequently, the strips have been made much too wide to secure erosion control. In other instances, strip cropping has been relied on for the control of erosion where it is very evident that both terraces and strip cropping should be employed.

Permanent grass or grass-legume buffers should be tried in many sections of the country where to date strip cropping consists largely of alternate strips of row crops and small grains. Deviations in strip cropping should be made in order that we may learn from actual results the type that should be recommended in any particular locality. Such deviations, should be based on the assumption that any change made will actually improve the chances for erosion control.

Establishment of Native Grasses

If our attempts in reseeding the native grasses of the drier regions are to be successful, we must keep in mind the importance of the fundamentals of such seeding. These are (1) a firm, almost solid seedbed; (2) proper depth of planting; (3) proper time of planting; (4) a mulch cover. The first three are generally known but in the past very little attempt has been made to provide a cover that will retain the moisture for a sufficient time to allow the seed to germinate. Possibly wheat stubble, weeds, Russian thistles, and other materials already on the land could be utilized. If, for instance, the seed is planted in a stubblefield and covered by running a cultipacker over it, much better results from the germination of small grass seeds may be expected than that from a very clean seedbed. This is particularly true where moisture is a limiting factor. Most of our native grasses are sufficiently hardy to live through the winter if they can be seeded in late summer when moisture is plentiful. If this cannot be done, late winter or very early spring seeding is recommended.

[1] In Charge, Agronomic and Range Management Section, Soil Conservation Service, Washington, D. C.

BLOTTERS INSTE

by Well

Editor ..... S

IT'S Nature's way in Minnesota.

It's bluegrass sod, and grassed waterways, and willow cuttings.

It's legumes, and small grains—in strips.

It's blotters instead of shingles.

Of Minnesota's soil-conservation projects, I visited four out of four. I talked with farmers. I attended staff meetings at night. From Garvin Heights, 575 feet above the town of Winona, I looked down upon the Mississippi Valley in panorama, with Lake Winona in panorama.

Yes, and wriggled through barbwire fences—re-threaded on contour—to examine new tricks in water-channel stabilization . . . groped down into a gully, its hoof-punched pockmarks obliterated by knee-high grass and a jungle tangle of young locusts . . . swapped yarns with "Lefty" Hymes, newspaper man anxious to "get going" under the new State soil conservation districts law.

I came in from a tour of the Deer and Bear Creek watershed, bearing samples of half a dozen different silt loams on parts of my anatomy, brought back to Faribault traces of the Carrington loam and silt loam for which the Prairie Creek drainage area is noted, nosed briefly into the Tama and Fayette soils of the Beaver Creek project at Caledonia.

For one solid week I dwelt midst the land and language of legumes, rotations, soil horizons, sheet washing, filter strips, bird-food patches, farm records, and taxation studies. By the end of that week I knew that Nature's way is Minnesota's way, that vegetation is both the theme and the reliance in cooperative erosion control on all four water-shed projects.

Take alfalfa, for example. Grimm, Baltic, Hardigan, in particular. In Minnesota U's Special Bulletin 104—

Badly eroded slope, John Bergler farm, where cow paths led to gullies. It is in the early spring of 1937; the snow in the ditches is 6 to 7 feet deep.

The same slope, May 1937, after smoothing and prepared for planting of sweet clover and black locust.

"Mike Redig brings his odd rows to the center."

In this view on the Vic Papenfuss farm, the shrubs in the immediate foreground are shrubs constituting part of a windbreak. They are followed, in order, by oats, corn, oats; across the draw the strips are oats, alfalfa, oats, and corn, oats, corn.

D OF SHINGLES

l Brink

worthy example of the editorial art—we are told that alfalfa is an A-1 soil-builder, a cheap source of protein for livestock, a grand hay yielder; dependable, adaptable, ideal in rotation.

DOWN at Spring Valley is visual confirmation. I found there that on 92 project farms alfalfa has tripled its acreage in 2 years! In the same span of time these farmers have also materially increased their permanent pasturage, added protection to their woodlots.

In the Deer and Bear Creek watershed the topography confounds by variety, ranging from almost level to hilly, steep, and rough. Control of sheet washing is by contour tillage, terracing, and strip cropping. Sharper slopes are going into hay, pastures, and trees. Rough, stony tracts are being taken from the plow and given over to hardwoods and conifers.

Specially in favor as soil safety-pins are caragana, buffalo berry, dogwood seedlings, cuttings of willow and cottonwood. Of proved merit here are white pine, Norway pine, jack pine, Scotch pine, ponderosa pine, Austrian pine, white spruce, Black Hills spruce, Norway spruce, red cedar, white oak, red oak, burr oak, pin oak, shagbark hickory, black walnut, hackberry, butternut, hard maple, soft maple, green ash, basswood, honey locust, and black locust.

The rapidly shifting conditions at Spring Valley, the two types of soil—forested and prairie—the wide assortment of slopes and characteristics, produce a kaleidoscopic picture of erosion control. Latest check-up revealed 114 cooperators in the official soil-conservation program, 13 other farmers seeking and receiving technical assistance and supervision, more than 4,000 acres strip cropped.

August—and stabilization. The wooded area above is given protection.

Wired-down sod flume draining 7 acres on farm of George W. Hazelton, near Racine, Minn. It replaces a gully which was 9 feet deep and 8 or 10 feet wide.

Diversion ditch in Winona County, fenced, sodded and planted to trees.

Strip cropping in Spring Valley. Observe the sodded draw between corn and grain strips.

A few random segments of the kaleidoscope:

A roadside farm notable as a notoriously "bad example." Erosion made it a bad risk for the Federal Land Bank. Eventually it sold for $20 per acre—just $20 per acre too much. It is the only abandoned farm in the area.

A 300-acre slope which until recently dumped its surplus waters into a creeping gully. Until C. C. C. labor did some intelligent filling, you would have crossed the gully on a bridge. Today the bridge is out and dirt is in. The draw below is taking care of an estimated discharge of 14 cubic feet of water per second, using a series of inverted chickenwire baskets in the channel and bluegrass sod on the rims. Of course, there is the inevitable barrier of barb-wire round about, enforcing a just-right ukase on grazing. Project Manager Jackson holds that properly grazed sodding is better than ungrazed.

A noteworthy departure in the form of a sodded draw with grass poking up through a mesh of wire spread to keep out woodchucks and gophers.

The Charles Steffins place with a road ditch sodded and farmed, with a masonry dam and rock apron—the rocks "puttied" in to circumvent damage by frost action. (If the job were to be done over, sod would substitute.) Farther down this same newly disciplined draw is a series of sodded humps. The farmer, of his own accord, taking his cue from numerous examples on nearby farms planted willows between. (This frequent apeing of demonstrated practices is known in shop jargon as "spread of practices"—a trend that serves to point the worth of project demonstrations.)

THEY dredged Lake Winona, fed by Gilmore Creek, a score of years ago—scooped it to a depth of 35 to 40 feet. Farmers skinned the hillsides of some of their most fertile soil—sent it down by slow freight to silt up the basin so painstakingly hollowed.

Herb Flueck, State coordinator, curved an eloquent thumb toward a brindle cow complacently browsing weeds far out from shore as he talked to me of the problem of soil losses in the area. "If erosion can be controlled here, it can be controlled anywhere."

Yet, even here on this exceedingly angular countryside, the raindrops and the soil particles are being securely tethered.

Witness the William Bergler farm.

Witness the Mike Redig farm.

Witness the Vic Papenfuss farm.

Witness the Louis Thill farm.

Witness the Henry Wessel farm.

It's a compact, narrow-breasted valley. Many a field lies partly within, partly without, the project boundaries. Many a farm began its transformation, therefore, on an experimental, tentative, trial basis. Many an operator had an unusual opportunity to adopt horizontal cultivation, contour strip cropping, restricted grazing, managed woodland, gully healing, on a part of his holdings while continuing his outmoded practices on the remainder.

And many an operator, as a result of checking and comparison, subsequently sought advice and assistance in extending modern soil conservation to every inch of his ground.

Wessel is the biggest farmer thereabouts. Wessel, fall plowing, whoaed his four mules, expressed his liking for the economy of transverse farming, told me, "I'd never go back." His land, greatly impoverished under "orthodox" farming in the past, is today entirely in strips—some of these bands containing as much as 12 to 18 acres each.

Other farmers of superior natural aptitude are, like Wessel, becoming better farmers. Quick to embrace improved methods, they are also alert to adopt new quirks that serve to make these methods still more efficacious. Strip cropping, for instance. Strip after strip in the Gilmore Creek area runs with both sides on the contour.

Redig, for instance, starts planting his potatoes and his corn at the outer edges of his strips, brings his odd rows to the center. He says that this system facilitates harvesting and cultivation, and further reduces water losses.

Brush dams, accompanied by strip cropping and rotations, are the usual restoratives for gully-gouged fields on the leaning walls of this watershed. One such field, one such gully, tells a story that is a repetition of innumerable stories. For years this field had been in corn. The slope, the drainage, the whole "lie of the land," spoke eloquently against the formation of gullies—and yet here was this gaping gash 2 to 4 feet deep, and growing alarmingly with every rain. Something had to be done, effectively and immediately. It could have been expensive masonry, but what it actually was, was bundles of small brush—butts uphill—supported by straw, wired and staked in place. The expedient was so simple, so inexpensive, so convenient as to be within scope of any farmer. At the time I saw this gully, it didn't look like much of a gully, after all. The farm's junior and silent partner, Nature herself, was doing a neat job of filling. The gully was hardly half its former size, and getting smaller with every big washer. Next season it will be "business as usual"—or better than usual—on this field, with mule and implements proceeding back and forth across the ditch without pause or hindrance.

Near Caledonia I saw beautifully laid-out single strips ribboning along the hillsides a full mile in length. This, too, is a land of broad-base Mangum terraces, of diversion dikes skirting the heads of gullies, of sodded waterways, of hitherto valueless farm groves now become revenue producers. Complete treatment is accorded each farm unit, according to its own peculiar set of requirements. And the running story of this treatment, as chronicled in printed signs along

the highways, takes one almost all the way from A to Izzard in the known lore of erosion control.

FORTUNATELY, on the Prairie Creek project, Faribault—fourth of the four Minnesota phalanxes of attack—prevention is the cure. Slopes are slighter, and erosion has been slower getting started. In this section of dairying and general farming, an alert husbandry today has an opportunity to stave off the tragedy of soil despoliation. Major attention is on organic reserves and rebuilding, on rotations and strip cropping, on switches from cultivation to grass. And among the erosion-combatting grasses, reed canary ranks pretty close to No. 1 where the land is low, hummocky, and peaty. Of this grass, says another of the excellent University of Minnesota series, Bulletin 137:

"No other forage crop, seed of which is available in quantity, will thrive so well on highly productive lands that are too wet for most other crops. On such lands, which would otherwise bring low returns or none at all, reed canary has yielded hay and pasture as valuable as, or more valuable than, the crops from equal areas of adjoining well-drained soils. It may be left undisturbed for several years and thus the best returns are obtained from the investment in seed."

But there is more than strip cropping and brush dams in the Gilmore Creek community. There are electric fences, hemming in lush stands of timothy, clover, redtop mixtures. There is winter wheat for cover. There are sod flumes, stabilized diversion ditches, fences replaced upon the contour as guides to the new farming system. There are woodlots managed for permanent income, and food-producing cover for wildlife. There are uses of vegetative materials that would constitute news to any agricultural engineer of the old school.

CONSPICUOUS in the "spread of practices" category is a large wealthy estate just outside the Beaver Creek project area, Caledonia. The manager induced several of the Soil Conservation Service specialists to contribute advice and supervision on Saturday afternoons and Sundays. He mantled the farm with contour-stripped vegetation. He broadcast in a descriptive booklet, "This farm is completely under erosion control."

Pastures are in prime popularity among farmers of this watershed. Every cooperator has at least one fenced-out woodlot; 80 acres in one typical 320-acre unit are so segregated. Abetted by the Service, one owner, whose only alternative was the construction of a masonry dam, ingeniously—and economically—devised a fence-protected stock pond which took safe and profitable care of the run-off from a grassed watershed of from 8 to 10 acres.

SPRING Valley, Winona, Caledonia, Faribault. Four representative watersheds: Deer and Bear Creeks, Gilmore Creek, Beaver Creek, Prairie Creek.

Deep fall painting the Minnesota valleys in the hues favored by butternut, walnut, maple, sumac, ivy, and oak.

Swift, cold streams where the sportive trout wait on a lightening of silt load.

Lights blazoning from the windows of rural homes where farmers again tally their books with black ink instead of red.

Cows milked, horses bedded down, barns locked.

Soils made secure, not only for tonight but for tomorrow.

SYNTHETIC GROWTH SUBSTANCES

(*Continued from p. 184*)

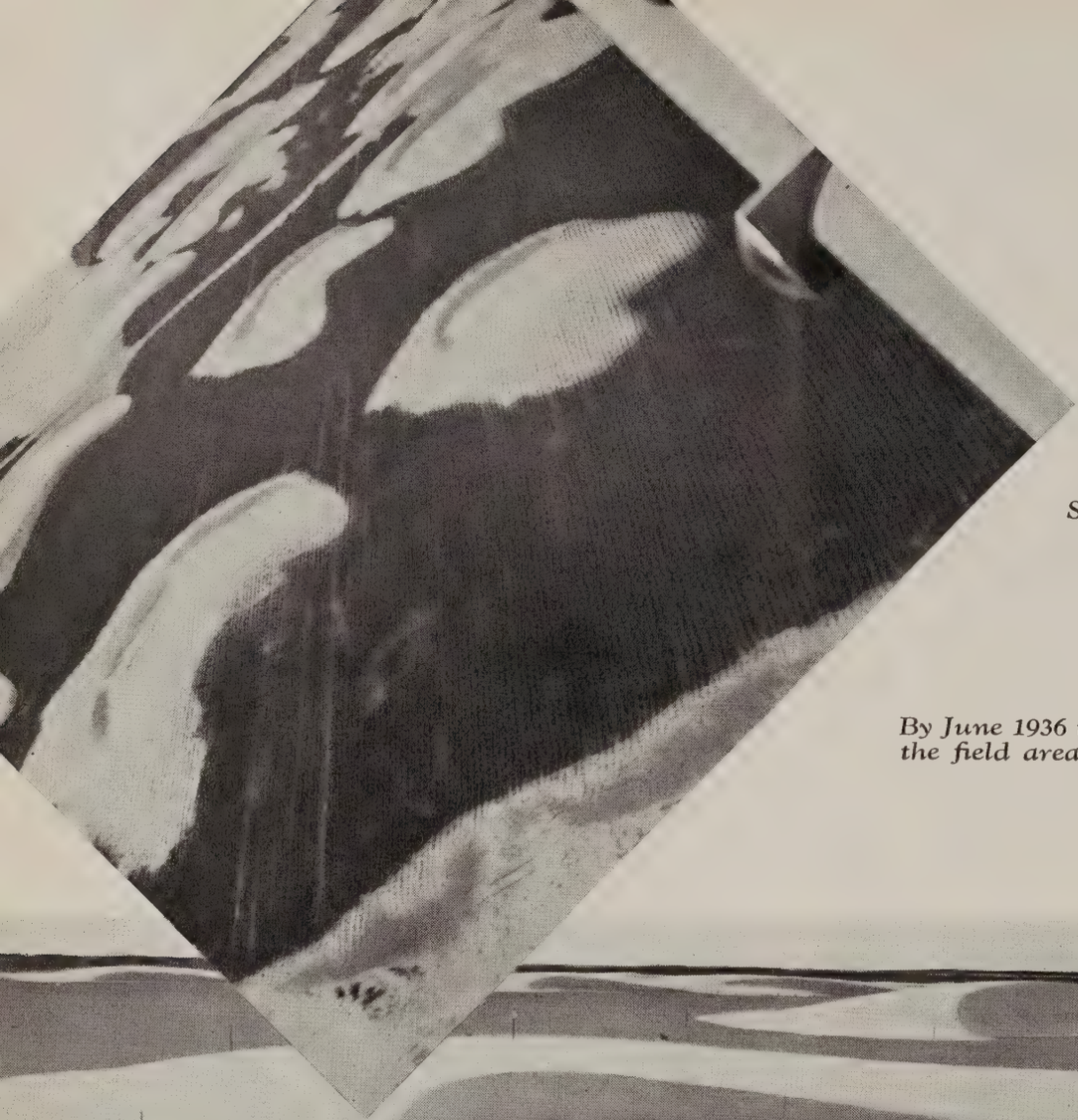
substances in practical use is possible. They are in no sense a panacea, and there are still many problems in propagation which they have not solved. With a few exceptions, such as the grape, hardwood cuttings have not responded to treatment, possibly because a good method has not been devised. Different varieties of the same species of plant may react quite differently. Thus, softwood cuttings of certain apple varieties rooted quite readily at the Boyce Thompson Institute following treatment with indolebutyric acid, while others would not respond. Much success has been reported with cuttings of *Taxus*, but Chadwick [14] did not obtain much stimulation with cuttings of most of the coniferous evergreens. Very good results with the broad-leaved evergreens, such as hollies, citrus, and some of the ericaceous plants, have generally been reported. Watkins [15] obtained excellent rooting with cuttings of various warm country plants, many of which offer much difficulty in propagation. The botanical and horticultural journals in many parts of the world now contain accounts of successful propagation of difficult plants with the aid of growth promoting substances.

The Boyce Thompson Institute has tested several hundred species and varieties of plants belonging to

(*Continued on p. 199*)

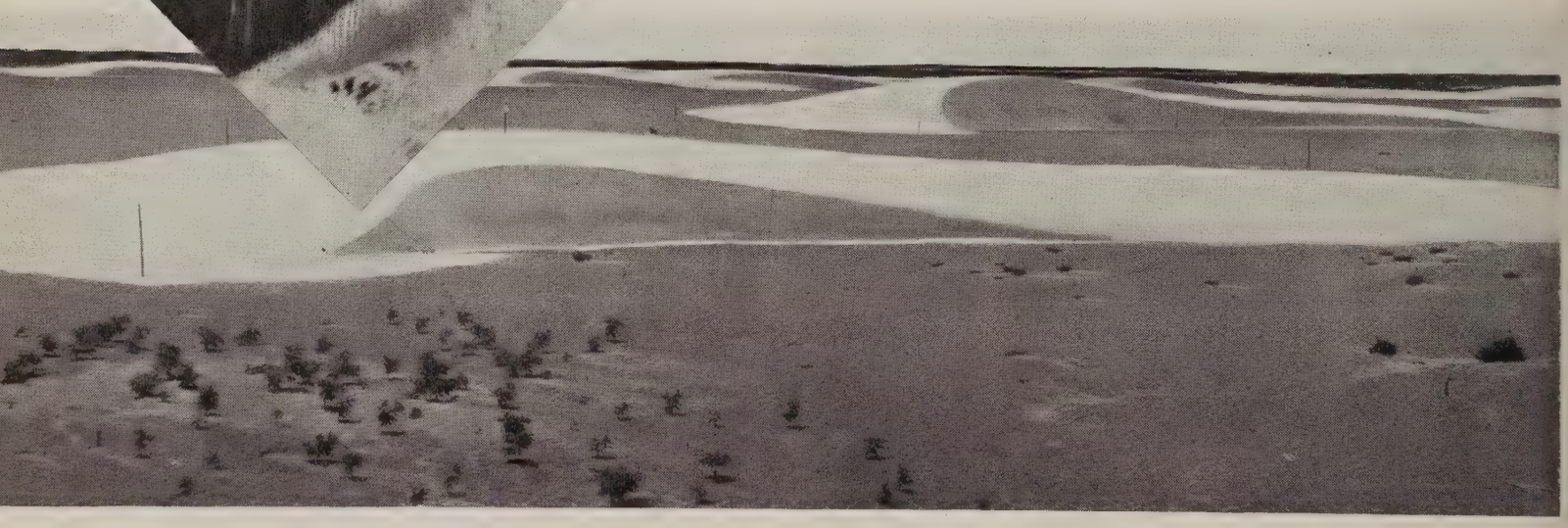
[14] Chadwick, L. C. Chemicals hasten root growth. American Nurseryman 65: 9–11. 1937.

[15] Watkins, J. V. Experiments with hormodin on tropical and semitropical plants. 1936.



Some of the dunes, as seen from the air.

By June 1936 there had developed 57 small dunes on the field area. The substratum around the dunes was hard and compact.



The RECLAMATION OF A SAND DUNE AREA

by

Charles J. Whitfield

and

Fred C. Newport

IN recent years sand dunes have developed as a result of cultivation, grazing, and drought on many sections of land throughout the southern Great Plains where previously no dunes were present. No more striking example of the destructiveness of man-induced wind erosion is known to occur elsewhere. Under virgin conditions topography of the land varied from nearly level to undulating or gently rolling, with a good grass cover and no evidence of dune formation.

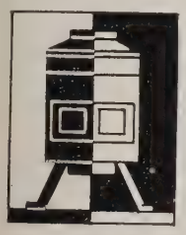
The dunes, as well as the surrounding eroded lands, have approximately no vegetative cover and are valueless in their present conditions; moreover, they are a source of constant menace to surrounding fertile

NOTE.—Mr. Whitfield is in charge, Division of Research, Soil Conservation Service, Dalhart, Tex. Mr. Newport is in charge, Agronomy and Range Management Section, Soil Conservation Service, Amarillo, Tex.

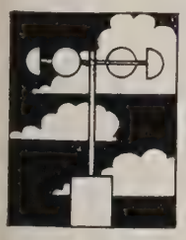
farm lands, pastures, and buildings. The seriousness of the situation can be well appreciated when it is realized that 10 years ago there were no dunes on many of these lands, and that the bulk of the damage has accrued during the past 7 or 8 years. Furthermore, many of these immense piles of sand are now found on areas that were never cultivated, i. e., native prairie sod.

LITTLE or nothing appears to have been done to cope with these severely eroded lands prior to the establishment of the Research Substation at Dalhart, Tex., and inasmuch as they are problems of considerable economic importance it was considered justifiable to initiate studies with the primary objective of determining whether or not such areas could be reclaimed for agricultural purposes. Accordingly, actual work was started in 1936 on three separate fields, while observations were made on numerous others.

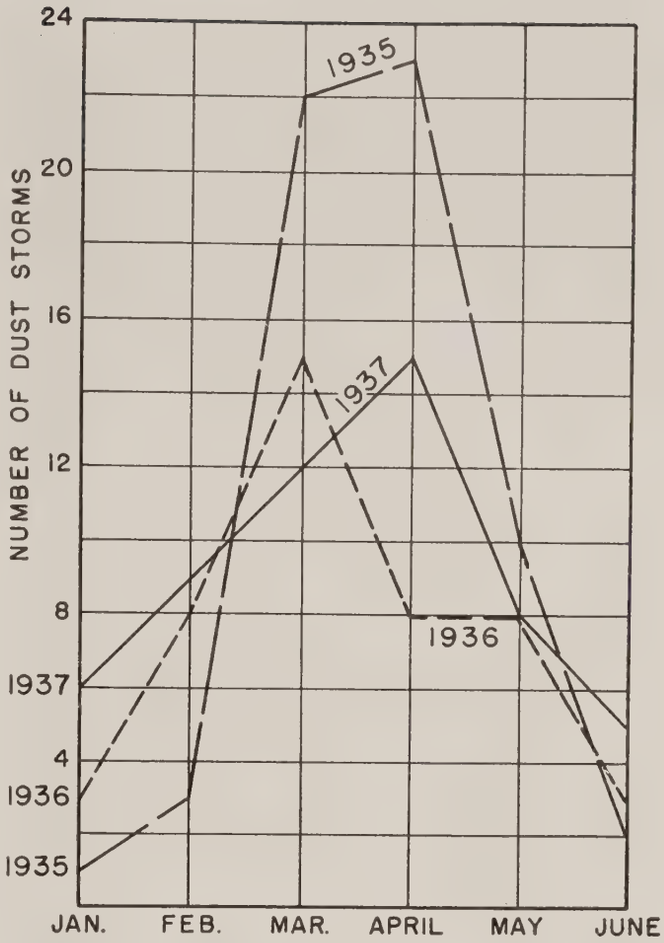
The data herein reported were taken from studies conducted on a single field of 470 acres which is located 8 miles north of Dalhart and consists of the northern portion of section 31, block 1, C. S. S., the eastern part of section 20, all of section 21, block 2, C. S. S. and part of the H. B. Hill survey. The field, which runs in a north-south direction, is over a mile in length and a half mile in width.



Two rain gages were established on the area in September 1936, to measure precipitation, one being placed in the northern half of the field and the other in the center of the southern portion. Data collected from these gages for the 12-month period, September 1936 through August 1937, showed a total precipitation of 11.94 inches. Compared to the 31-year average of 17.84 inches (1906–36) at the United States Dry Land Experiment Station, 3 miles west of Dalhart, this was 5.9 or nearly 6 inches below normal. Moreover, from May 29, when 1.97 inches of rain was recorded, although 16 rains fell, not one of these averaged over 0.5 of an inch until August 31, on which date 1.13 inches was received. These data indicate an abnormal season both as to amount and distribution of rainfall.



Wind velocity data recorded in the vicinity of the area where the field work was conducted showed the average wind movement to be highest during the 5 months—February through June—with the maximum of 12.39 miles per hour occurring in March.



Dust storm record during blowing seasons of 1935, 1936, and 1937.

During these months velocities averaged above 10.5 miles per hour, with February, March, and April being especially high. Winds of sand-moving velocities come from the south, southwest, west, northwest, and northeast; however, indications are that over a period of several months more winds of this kind come from the southwest. Records being kept by the Dalhart demonstration project in cooperation with the Research Division show that it is during this period that the dust storms are of greatest frequency. The total number of dust storms recorded were 61 for 1935, 45 for 1936, and 55 for 1937.

When this field was purchased by Dawson, Fuqua, and Price, in 1930, it was dominated by natural vegetation with blue grama, *Bouteloua gracilis*, and sideoats grama, *B. curtipendula*, as the principal grasses, with sand sage, *Artemisia filifolia*, as the outstanding shrubby plant. The original soils were probably Amarillo fine sandy loam and Amarillo loamy fine sand.

In 1931 the area was cultivated for the first time and planted to row crop. It was planted again to a row crop in 1932 and 1933. Only one crop was harvested

Deep listing of hard land in which the substratum was broken into clods that catch and hold moving sand and do not erode easily.

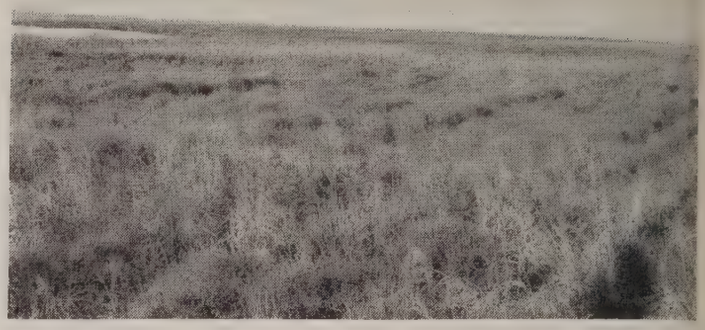
during this 3-year period. Because of drought and crop failure the land lay idle after 1933 until this work was started in 1936.

When this field was surveyed in 1936, it was found that there were approximately 57 sand dunes located for the most part on the east half of the area. The dunes ranged from 1 to 9 feet in height and averaged 161 feet in length and 113 feet in width. The substratum around and between the dunes was hard and eroded to a depth of 10 to 12 inches. The north and south portions of the field were hummocked and not as badly eroded as the center area.

Studies were conducted on the rate and amount of dune movement on this field site during the fall of 1936. For the 10-week period, August 18 to October 27, 14 dunes were measured, all of which were found to have moved in an easterly direction. Maximum movement recorded was 155 feet. One dune disappeared completely. The average movement from the typical dune ranged between 20 and 30 feet.

The average wind velocity for the 10-week period was 7.45 miles per hour with a maximum of 32 miles per hour.

Work was started in November 1936, on that portion of the field dominated by the hard eroded land and sand dunes. The entire area, including the dunes, was solidly listed (42-inch rows) to a depth of 8 to 10 inches in an east-west direction or crosswise to the prevailing wind direction. A 40-horsepower diesel tractor and a 3-row lister were used. The value of deep listing cannot be overemphasized. Shallow listing may only be conducive to additional blowing, while deep listing, when done in the fall, will not only reduce the blow hazard but prevent erosion, by turning up



A repeat of picture at left, made October 1, 1937. Sudan grass and kafir corn are making a luxurious growth on an area formerly dominated by a hard substratum and sand dunes.

clods of sufficient size to withstand erosion for from 1 to 3 years. In addition, this cloddy surface catches and holds the material which moves off the sand dunes, causing the latter materially to decrease in size, and filling the lister furrows with sand—thus is this badly damaged land being rebuilt. An airplane view made of this field in March 1937, 3 months after the listing was completed, shows clearly how the action of the wind may be used for redistribution of soil materials to rebuild eroded lands. During this period it was estimated that approximately 60 percent of the soil material had been spread back over the field, while the number of dunes decreased from 57 to 29.

Listing was completed in December 1936, and it was unnecessary to relist, except on local spots which were exposed when the sand dunes moved completely away leaving the hard, smooth substratum.

No other mechanical treatment was made on the area until early June 1937, when it was planted to row crop. In order to compare the erosion-resisting qualities of different crops, five species (Sudan grass, kafir corn, black amber cane, millet and broom corn) were listed, while two species (Sudan and hegari) were drilled on the field. The north and south borders were listed as a preventive measure against crop failure and wind erosion, while the center portion was drilled that the two types of cover produced by these methods might be compared.

By harvest time (October) a good cover crop was secured over the entire field, but growth was expecially good on the east half of the area where the sand had redistributed itself to a greater extent. A comparison of the various species planted showed that broomcorn developed a better stand and produced a more vigorous growth under the different soil conditions; Sudan

grass was second in importance, with black amber cane and kafir corn close competitors for third place. From an erosion resistance standpoint, these species also rank in the above order. In other words, broomcorn and Sudan grass appear more resistant to wind action than the other species. However, the forage value of the species would likely be in reverse order, with kafir and Sudan ranking at the top. Probably more Sudan is planted over the country because of its rapid growth, drought resistance, and excellent grazing qualities.

As a result of a soil-conservation reconnaissance survey of the Southern Great Plains wind-erosion area, it was found that "a large proportion of the cultivated and idle lands has already been seriously and irreparably damaged. Pasture lands, which ordinarily are considered well protected by a natural cover of vegetation, are extensively affected by slight erosion and 26.9 percent by serious erosion. Considering lands of all use for the whole area, 9.8 percent has been severely or very severely damaged, which essentially means that it has no further crop-production value." [3]

The studies already initiated, in which wind action, the force primarily responsible for the severe erosion damage, is successfully used to rebuild a severely damaged area to the extent that crops may be produced at a profit after one year's time, present an open question as to the amount of land "irreparably damaged" in this region. Wind erosion differs from water erosion in one primary essential: When soil is carried away by water it is impractical and often impossible to move it back, whereas the action of the wind will often reverse itself and return much of the materials it was instrumental in carrying away. With this as a guiding principal and by the proper use of tillage methods and vegetation, lands which were considered so badly eroded as to be no longer of value from a crop production standpoint may be reclaimed for agricultural use.

[3] Joel, Arthur H., Soil Conservation Reconnaissance Survey of the Southern Great Plains Wind Erosion Area. U. S. D. A. Tech. Bull. No. 556. p. 34. 1937.

Sand moving from the dunes is caught and held in lister rows between dunes.

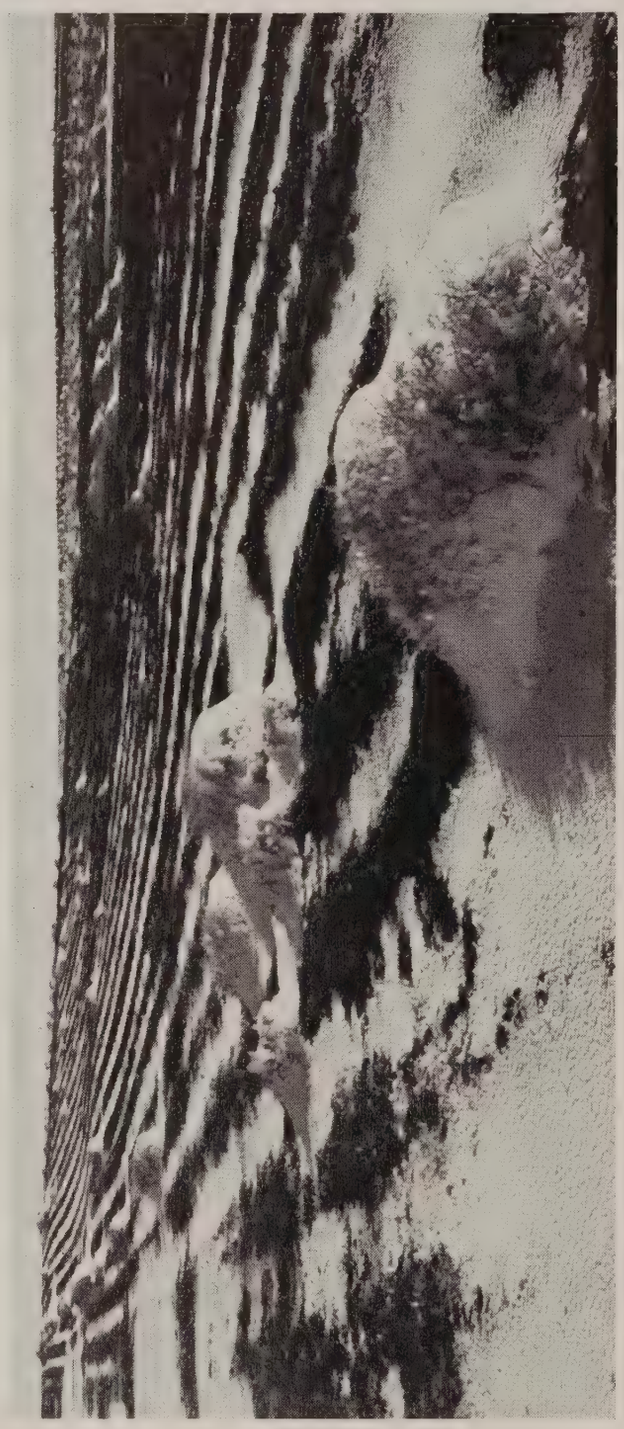
A repeat of picture above, indicating how badly eroded land has been reclaimed with the development of good row crops after 1 year's time.

Reseeding Grasslands

Three years ago we were of the opinion that a tremendous acreage of grassland, both in semiarid and humid regions, was so seriously damaged by over grazing and neglect that reseeding was necessary. Today, however, after having reviewed the results secured over the 3 years, it is quite apparent that in most localities proper management will bring back a grass cover much more quickly and economically than will plowing and reseeding. Extraordinary results in grassland improvement are secured where weeds are mowed at the proper time and grazing is regulated or restricted for a period of time.

Sixty percent of the native grass in eastern Nebraska has been killed by the drought of the past few years. Undoubtedly, much of this grass would have survived had it been properly managed previous to and during the drought period. Fifty-seven percent of the land in the State is still grassland, although much of it is in very poor condition. When it is considered that 80 percent of the State's agricultural income is from livestock, the importance of grassland is immediately evident.—C. R. E.

"For with the soil washed away, or reduced to sterility, the sea would be the only source of food, and men would become as the fabled icthyopophagi, a rare and scantily fed species, dwelling on the shore and subsisting on what the waters afforded."—Nathaniel Southgate Shaler; Man and the Earth, N. Y., 1906, p. 120.



Basin Listing to retain Snow Moisture

by V·H·Florell.

This snow held in lister furrows and clumps of Russian thistle illustrates advantage of vegetative cover and rough tillage obstruction.

A FIELD experiment was planned in the fall of 1936, to obtain information on basin listing for conservation of moisture from snowfall. The listing was done on cooperators' farms within the Wolsey-Shue Creek demonstration area in South Dakota, from November 18 to December 2, 1936.

The specific objective was to compare the effectiveness of basin listing with that of ordinary listing, and to contrast results from these methods with those obtained on untreated fields previously used for grain and row crops where wind strip cropping is practiced. The plan followed was to basin list, to ordinary list, and to leave untreated about equal parts of each field under experiment. The operations were done on the noncontour because this is the practice followed in wind-strip-cropped fields of undulating topography common in this section. The relative moisture penetration was to be studied at the time of listing and at the end of the winter season.

Materials and Methods

A 3-row lister was used, the lister bottoms being adjusted to cut furrows 42 inches apart. The damming attachment constructed dams at distances of 10 feet. The depth was adjusted to make the listed ridges from 10 to 12 inches high; and the attachment was so arranged that the dams built were from 8 to 10 inches high.

A 1.5-inch soil auger was employed in making the borings for the moisture-penetration observations and an extension auger for some of the deeper borings. All depths of moisture penetration were measured in inches.

In order to obtain a comparison in effectiveness of conservation of moisture run-off, most of the borings were made on slopes of 2 to 4 percent. In the listed portions of the fields most of the borings were made at the bottoms of lister furrows, and in the basin listing usually midway between the dams. For any two treatments under comparison the borings were taken reasonably close together. The types of soil and subsoil were noted for each individual boring. On the

NOTE.—The author is associate agronomist, Soil Conservation Service, Rapid City, S. Dak.

average, four borings were made in each comparison.

Experimental Data

Due to freezing of the soil it was not practicable to make moisture determinations at the beginning of the experiment. A number of scattered observations on other fields in the demonstration area, however, were made late in the fall which gave a fairly good idea as to the depth of soil moisture at the time of listing. In the Wolsey area the average depth of moisture penetration was approximately 8 to 12 inches in grainfields, and 18 to 20 inches in cornfields. Moisture penetration naturally varied from these figures with different locations and in different soils.

The spring thaw, early in March, was followed by blustery weather for several weeks, and the ground remained frozen until late in April. The borings for the moisture study were made during the period, April 17 to 21. It was found that the lower limits of moisture penetration could be distinguished easily, due to the previous extremely dry condition of the soil. In most cases the limits of penetration were marked by an abrupt change from wet to dry.

The table presented gives a summary of the average moisture penetration in inches for comparable borings. Since the depths of penetration varies according to land use during the season the data are segregated on a land-use basis.

Cornfields were sampled on three farms. As stated previously, the moisture penetration in cornfields in late fall was estimated to average from 18 to 20 inches. In basin-listed land the penetration was 43.8 inches as compared with 30.9 inches on untreated fields, and in the ordinary-listed land on two farms, 37.7 inches as compared with 30.2 inches on the untreated.

Basin listing; dams about 10 feet apart, 6 to 8 inches high. This field is representative of many in the section.

Summary table of results obtained in a comparative soil moisture penetration study of fall basin-listed and ordinary-listed fields on the Wolsey demonstration area, Soil Conservation Service, Huron, S. Dak., April 1937

Number of farms [1]	Predominating soil types	Previous crop (1936)	Treatment	Number of samples	Average moisture penetration (inches)
3	Barnes loam and gradations of fine sandy loam; subsoil, fine sandy and silty clay loam.	Corn	Untreated	9	30.9
			Basin-listed	9	43.8
2		Corn	Untreated	8	30.2
			Ordinary-listed	8	37.7
1	Barnes fine sandy loam and Bearden loamy fine sand; subsoil, mostly sandy loam but some clay loam.	Corn [2]	Untreated	2	92.0+
			Basin-listed	4	85.0+
4	Barnes very fine sandy, and fine sandy loam; subsoil, fine sandy and silty clay loam.	Small grain	Untreated	22	22.9
			Basin-listed	22	24.7
5		Small grain	Untreated	14	26.2
			Ordinary-listed	14	22.8

[1] Not all comparisons were included on all farms.
[2] Data here not included under "Corn" above.

(Continued on page 200)

Rebuilding Pasture Soils

An excellent pasture of white clover may be developed by application of lime and fertilizer.

By Arnold S. Dahl [1]

IN the improvement of old pastures and the establishment of new ones the agronomists of the Service find two of their most difficult problems, and they are well aware that the fundamental cause of the difficulty lies in the low fertility of the soils upon which most pastures are located or planned. In the past, many farmers devoted to pasture only their poorest land, or land that otherwise could not be planted to crops. Other pastures have been established on worn-out croplands, or on soils depleted by years of grazing without replacement of the plant food elements which had been removed in the form of livestock products. Again, many pastures have been injured by overgrazing or improper seasonal grazing, and this misuse has resulted in a poor growth of desirable vegetation and the development of sheet erosion and gullying. This erosion has been accompanied by progressively poorer production and intensified overgrazing, until finally the true pasture plants, which require a high level of fertility, have disappeared to be replaced by weeds such as poverty grass, broom sedge, cinquefoil, broom weed, and others.

IN the humid sections of the country, a pasture vegetation composed mainly of weeds, with much of the ground devoid of cover, is usually indicative of low soil fertility. In such a condition it is necessary, before any success can be obtained from seeding, to raise the level of fertility to a point that will support a vigorous growth of the true pasture-type plants. Usually this can be done by applying fertilizers.

In fertilizing a pasture care should be taken to apply sufficient amounts to produce a high level of fertility in the beginning, rather than to use small amounts annually over a period of years. This allows the better plants to attain sturdy growth within a rela-

[1] Agronomist, Soil Conservation Service, Washington, D. C.

Left—A good turf consisting of grasses and clovers produces abundant feed and provides control against loss of soil and water.

Center—New pasture developed on land retired from cultivation in 1936. Rolling land and natural draws can profitably be used for pastures, with correct fertilization and pasture management.

Right—A poor turf consisting of yarrow, poverty grass, buckthorn, plantain, ragweed, and other weeds. Such a turf provides little feed and poor protection against soil losses.

Left—Contour furrows constructed with machine which does not destroy sod.

Center, below—Contour ridges on level land saves water for use of vetgetation.

Center, above—Contour ridge now completely covered with Bermuda grass. Fertilizer treatments and water conservation pay dividends in increased vegetation.

Right—Overgrazing coupled with low soil fertility induces erosion on hillside pastures. This pasture will continue to lose soil and water until fertilizers are applied and grazing is controlled.

tively short time, and this growth will continue to be vigorous as long as the pasture is properly managed and maintained. Once a pasture is established on a highly fertile soil, the maintenance is easy and production on a high level will continue. On the other hand, when small amounts of fertilizer are applied to depleted and eroded soils there may be little or no response, as the vegetation may be too weak and sparse to prevent erosion or to produce sufficient forage to ustify expenditures for fertilizers. Pastures may thus continue to be poor throughout many years in spite of the usual annual applications.

LIME should be applied to bring the pH value above 6. This may require 1 to 3 tons of limestone per acre. Lime will not only provide a favorable medium for the growth of legumes, but will also encourage the growth of desirable pasture grasses. The addition of lime will tend to make the application of fertilizer more effective and result in better growth of pasture plants.

In certain soils, phosphates, when applied in fertilizers, combine with the chemical constituents in the soil, such as iron and aluminum compounds, and become insoluble and unavailable to the plants. Fixation of this type usually takes place to a greater degree in acid soils of heavy texture. Phosphates may also be combined into relatively insoluble calcium compounds which, however, are less insoluble than the compounds formed in acid soils. As a rule, fixation of phosphates is more complete in heavier soils which are low in organic matter. The addition of organic matter tends to make phosphates of the soil more available—this due to the dissolving action of the acids formed in the decomposition of the organic substances. In a soil well supplied with lime and organic matter, fixation of phosphates ordinarily is not serious. On poor acid soils, however, it is necessary to apply considerable quantities of phosphatic fertilizer to get any immediate response. With the addition of lime, and as organic matter is built up, the fixed phosphates may become available slowly and supply plant needs over a period of years.

The amounts of fertilizer to be applied will vary according to soil type and deficiency of mineral elements. As a rule, agronomists have been too conservative in their fertilizer recommendations. An application of 800 pounds of 16-percent superphosphate per acre once in 4 years is better than 200 pounds per year, or 400 every second year. A heavy application of superphosphate will stimulate legume growth, which in turn will stimulate grasses.

Except in a few specific cases, the use of nitrogen fertilizers is not economical on pastures. Where there is a shortage of feed early in the spring, an application of 100 to 200 pounds of sodium nitrate will give excellent results in encouraging early spring growth so that grazing may begin 2 or 3 weeks earlier. On badly depleted soils which are being seeded to pasture mixtures, applications of nitrogen will result in a quicker and more vigorous plant growth, thus greatly enhancing the possibilities of success from the treatment. Nitrogen fertilizers may also be used to advantage on certain dairy farms where intensive production methods are employed. For the general farmer, however, it is more economical to manage the pastures in such a way that white clover and other legumes will thrive and supply

nitrogen to the grasses. If the mineral plant food content of the soil is adequate, combinations of legumes and grasses are very successful in producing high yields.

Soils in pastures usually are not as deficient in potash as in phosphorus, lime, or nitrogen. In certain soils, however, particularly the lighter soils, and in certain sections of the country, pasture plants respond to applications of potash. In most instances the response to potash is greater when used in addition to nitrogen, phosphate, and lime treatments. Applications of 100 to 200 pounds of muriate of potash are used successfully to satisfy potash deficiency. To determine the need for this fertilizing element, before extending any general recommendations regarding its use, it may be advisable to make a few applications of potash in strips across the fields.

When a farmer has a very large acreage of depleted and eroded lands, the cost of rebuilding fertility of all soils may be more than he can bear. It is advisable, on such a farm, to treat completely as much as the farmer can afford, whether it is 5 acres or 10 acres, and to follow in subsequent years with treatment on additional acres. It is particularly important, in treating pastures to rebuild the fertility of the soil, that a complete treatment be applied on a small acreage rather than an incomplete or inadequate treatment on a larger acreage. A good small pasture will produce returns over a period of years, and the farmer is convinced that it pays to fertilize pastures and is encouraged to treat larger areas. By treating additional small areas year after year, throughout the country, sufficient pasturage can be developed to supply all livestock on all farms without overgrazing. This plan should be definitely provided for in the cooperative agreement, so that at the end of 5 years farmers may have adequate pasturage to meet their needs. Where there is a surplus of land, if not suitable to be placed in crop rotations, the balance can be used for tree production.

The initial application of fertilizer on a pasture should be considered a permanent improvement, not a maintenance measure. The procedure is analogous to the construction of a barn, with initial cost relatively great and with maintenance required as time passes—if a poor barn is built it will always be a poor barn and maintenance costs will be high. Similarly, if a poor pasture is established it will always remain a poor pasture and will depreciate rapidly and require costly maintenance.

On many soils it is not possible to establish stands of sweetclover and alfalfa. Most of these soils are acid and depleted of mineral plant food and organic content. In sections where lespedeza is adapted it grows well on these poor soils. Lespedeza, however, ordinarily should be looked upon as a means to an end rather than as climax vegetation—it is valuable as cover until conditions are such that lime and phosphates may be applied, after which sweetclover can be successfully grown.

Alfalfa cannot be established, even with proper applications of lime and phosphates, until the organic matter content is built up. Here the role of sweetclover is important, as it is often possible to establish alfalfa on land which has been planted to sweetclover over a few years. In sections north of the lespedeza areas, alsike, white clover, and sweetclovers, in mixtures with grasses, may be similarly adapted. Obtaining stands of alfalfa and other high-producing legumes is a matter of building up the fertility of the soil, and should be the ultimate aim of a soil-conservation program in pasture areas.

Maintaining a high level of pasture productivity during summer months is a difficult problem. This is particularly true of pasture containing a large proportion of Kentucky bluegrass which becomes dormant when subjected to periods of high temperatures and drought. In this the condition of the sod is an important factor, since, naturally, the temperature of the soil is much lower under a good sod than under a poor sod. Thus, when the sod is thick and vigorous and has sufficient moisture, air temperature is not so important for the production of forage. On properly fertilized and managed pastures it is moisture that is often the limiting factor and, therefore, the conservation of water becomes the important means of maintaining production during the months of July and August. By holding on the pasture the fall and early summer rains, and those that fall during dry periods in midsummer when the grass is closely grazed and the ground hard, this problem of summer productivity could be mitigated to considerable extent.

Contour furrowing for conservation of water is becoming an important feature of the management of pastures, and the practice has met with considerable success both in the dry regions of the West and the humid regions of the East. In the latter regions, moisture is only one of the limiting factors in the growth of vegetation, lack of soil fertility being most important throughout the greater part of the year. Nor can contour furrows be expected to take the place of fertilizer treatments since, in fact, it is frequently necessary to apply more fertilizer to the furrows and ridges than to the balance of the pasture—

this because of the poorer soil that is exposed in construction.

A great many furrows have failed to show any improvement, and some have actually caused decreased growth, because they were not sufficiently fertilized. Without doubt it is important that contour furrows be fertilized heavily if prompt results are to be realized.

In the West, where gentle slopes prevail, contour ridges which back the water over a large area when spaced relatively far apart, have proved very successful. In the East, where the land is more sloping, such ridges are less satisfactory. Many of these furrows are too deep and the ridges too high and too large, the greatest amount of improvement in the turf occurring in the bottoms of the shallow furrows and not extending, except in a few cases, very far from the limits of the furrows, thus leaving the greater part of the sod in the interval between furrows unimproved. It is apparent, therefore, that wide shallow furrows placed to adjoin one another will provide the greatest conservation and the best distribution of the water. In fact, when a few of these furrows were observed the broad band of vigorous vegetation was very marked.

Broad, flat-bottomed contour furrows can be built by one round of a disk harrow, leaving a broad shallow depression with sloping sides. A similar furrow can also be constructed by throwing two furrow slices in opposite directions, one up the slope and the other down the slope, and leaving a 6- to 10-inch balk in the center of the dead furrows. A harrow is then run over this balk to spread topsoil in the bottom of the furrows and on the sides. These furrows may be close enough together to allow backfurrows and dead furrows to alternate on the contour across the field. Such construction leaves a concave type of surface on the field, rather than the convex type usually seen where contour furrows have been built. As for the area improved through conservation of water by means of this type of construction, it will vary in size according to the amount of surface in the furrows and ridges—the greater the area in the furrows and the more diminished the area in the ridges, the wider the distribution of water for utilization by the pasture plants. The construction of furrows as outlined above replaces plowing in the preparation of a seedbed, thus necessitating little additional cost in establishing new pastures and in improving pastures where the sod is so poor that plowing is advisable.

If a fairly good sod is present, it is not usually advisable to plow the pasture; instead, in such a field, the furrows should be constructed with other implements. A chisel-type subsoil plow, run on the contour at a depth of 24 to 30 inches at intervals of 3 to 4 feet has been used to form a series of small ridges with wide shallow flat-bottom depressions between them, and this method appears to be very satisfactory in conserving water and in promoting growth on some soil types. It is not known, however, how long such ridges will retain an effective height. A new type of contour furrowing machine, lately developed in Iowa, constructs furrows without injuring any of the sod. Such machines are needed in all projects where contour furrowing is required on pastures with fair sod already present.

A good sod in a permanent pasture cannot be developed in a single year, chiefly because most of the important plants are perennial and require time for development in size and number. The first year's growth will consist mainly of annuals and short-lived perennials, and these will gradually be replaced by the permanent vegetation. Many newly seeded pastures which apparently are making very poor growth will develop in time to a vigorous sod. Likewise, it takes time for lime and fertilizer treatments to become fully effective. The time required to develop a good sod is considerably shortened, however, if contour furrows are constructed and if a liberal fertilizer treatment, with manure or mulch, is applied.

SYNTHETIC GROWTH SUBSTANCES

(*Continued from p. 189*)

about 85 different genera, and almost all of these have responded in some degree to the treatment. The few plants which could not be rooted may possibly be handled successfully later when more is learned about their individual requirements. The value of the treatment for rooting the most difficult plant subjects is not well enough established to justify unbounded enthusiasm. The shortening of the time of rooting of cuttings and the increasing of the number of roots produced are sometimes the only noticeable benefits. However, if so much progress has been made in the past few years, may we not hope for even more in the future?

A masterly summary of the theoretical and practical aspects of plant hormones has just been written by Went and Thimann.[16] These authors have done much to systematize and correlate the scattered mass of facts about plant hormones. While the phytohormone is

(*Continued on p. 202*)

[16] Went, F. W., and Thimann, K. V. Phytohormones. New York. 1937.

BASIN LISTING

(*Continued from p. 195*)

Data obtained from one cornfield were not included in the above averages. The soil here consisted chiefly of Bearden loamy fine sand and Barnes fine sandy loam which are underlain by a sandy loam subsoil and some clay loam subsoil. The subsoil in a number of the borings was mostly sand. These soils absorb water readily and Bearden particularly is very susceptible to wind erosion (blowing). Both on the untreated and on the basin-listed parts of this field an abundance of moisture was present to a depth of more than 7 feet (92+ and 85+ inches respectively). No dry soil was found in any of the borings. On an adjoining field sown to grain in 1936, but overgrown with Russian thistles, the average depth of moisture penetration was 25.5 inches.

The total precipitation from December 1 to April 21 was 5.01 inches of which 4 inches were from snow. The precipitation after April 1 was partly rain and partly snow. Snow at this time was very wet and heavy. From December 1 to April 1, 40 inches of snow was reported by the United States Weather Bureau at Huron, S. Dak., with a water content of 4 inches. The precipitation and snow at Wolsey was virtually equal to that at Huron.

All cornfields under treatment had been practically denuded by grasshoppers. Where grain had been sown in 1936, a more or less dense growth of Russian thistles occurred. On the average, the weed growth was from 3 to 6 inches tall and usually with only a moderately dense stand of plants.

Measurements of moisture penetration on grain land were taken on five farms. The average penetration on the untreated land for all samples (36) was 23.9 inches, on basin-listed land 24.7, and on the ordinary-listed land 22.8 inches. Very little additional conservation of moisture was effected by the use of basin listing above that of ordinary listing, or above that on untreated land. Here very little soil moisture increase was obtained in the basin listing, and negative results were obtained in the ordinary listing.

In comparing these fields it should be mentioned that the average depth of moisture penetration in the lister ridges was somewhat greater than that at the bottom of the furrow, and that an addition of about 2 or 4 inches might be made to the figures given for both basin listing and ordinary listing. The limits of moisture penetrations in a number of adjacent furrow and ridge determinations, however, averaged several inches lower below the furrow than below the ridge.

Borings were taken also on two fallow fields with the adjoining untreated fields for comparison in each instance (four samples for each comparison). These fields had been sown to grain in the spring of 1936. The average depth of moisture penetration for the fallowed fields (plowed in June) was 18 inches, and for the adjoining fields, 25.3 inches. This shows a greater amount of moisture on the untreated land than on the fallowed land. Apparently this is an unusual condition partly due to limited summer rainfall.

The total average rainfall from July 1, 1936 to April 20, 1937 (data from two cooperative weather observers near sampled fields) was 9.12 inches which was but 4.55 inches above that received from December 1 to April 20. Since rainfall was limited, very little moisture was stored by fallowing during summer. Some run-off also may have occurred from the moderately heavy August rains.

Throughout most of the winter the fallow as well as the denuded cornfields were free from snow. The adjoining fields covered with a moderately dense, though short growth of thistles, held much of the snow where it fell, the result being that the untreated land showed considerably more moisture penetration than the fallowed land.

From the data presented in the table it may be concluded that a significant amount of moisture was conserved by use of the basin lister on denuded cornland. An increased soil-moisture penetration of 12.9 inches above that of the untreated was shown for the basin listing, and 7.5 inches for the ordinary listing, or an increase of 40.4 and 24.8 percent respectively. These results indicate that a significant amount of snow moisture may be conserved by using a lister on bare land in the winter. The amount of moisture saved depends largely on weather conditions. In a cold winter when the ground is frozen to a considerable depth with much snow, followed by a rapid spring thaw, it is likely that most of the snow water would be lost as run-off on both untreated and ordinary-listed land having appreciable slope. Basin listing in such a case would do much good in trapping the moisture. During the past season the spring thaw occurred gradually, permitting snow moisture to penetrate the soil to a greater extent than it would have done under conditions indicated above.

Very little increase in moisture penetration was observed between the basin listed and untreated portions of fields on grain land, and negative results were obtained with the ordinary lister on grain land. The unlisted portions were well covered with Russian thistles. The thistles held considerable snow which on the average was estimated to be somewhat greater than that held by the lister furrows. The results ob-

(*Continued on p. 202*)

BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

SOLON ROBINSON, PIONEER AND AGRICULTURIST, Volume II, 1846–51. Edited by Herbert Anthony Kellar. Indianapolis. 1936–37

We welcome volume 2 of the writings and letters of this pioneer conservationist who more than a century ago warned farmers about taking the "skin" off the land and suggested rather ironically that if the people could not be induced to preserve and cultivate the natural forest it was the duty of the Government to plant groves of timber on the vast tracts of the western prairie land.

Upon viewing Stone Mountain, in 1851, Solon Robinson described the phenomenon as "an immense mass of naked granite . . . a landmark that will endure forever" and added half regretfully "If it had been a lime rock, it would have been more valuable to the agriculturist." And, far northward from the salubrious climate of Georgia, in Kingston, Ontario, witnessing the march of somewhere near a thousand of "Her Majesty's Rifles" through the street, he remarked that the soldiers were all "stout, athletic young men, and I could not help thinking what an amount of human food might be produced by the well-directed labor of all these eaters of the bread of idleness." Such a man was Solon Robinson throughout his years—living, hoping, and planning for agricultural improvement. For cities he had little use. Railroads might prove of value—for hauling lime to worn-out acres and farm produce to markets. The manufacturer had his place in the sun as the producer of equipment for deep plowing, subsoiling. Quartz rock was for garden walk borders, to beautify the farm-home surroundings.

In these middle years of his life he traveled the country over searching out the "improving agriculturist" that he might write descriptions of better farm methods, contrast "slack" and "snug" farmers and their establishments.

His enthusiasm knew no bounds when in his travels in the Carolinas he came upon a planter who would not allow his great plantations to be "utterly ruined" by the methods of overseers, but who took the situation in his own hands and "determined to apply the knowledge he had gained from reading and traveling, and devote all the energies of his strong mind to an effort to change that old, ruinous system which has nearly destroyed and depopulated some sections of the South." Continuing eagerly, words tumble over words as Solon Robinson describes the amazing innovations on the great plantations: "In the first place, cotton is utterly discarded from the premises, and clover—yes; rich, luxuriant red clover, by the hundred and thousand acres—has been made to grow where nothing but broomsedge and old field pine grew before."

Rotation cultivation on these plantations excited his admiration and with ardor he outlined the system for readers of the American Agriculturist: ". . . commence with a field at rest and plow 10 inches deep in April or May and sow cowpeas broadcast and harrow in; or break up . . . in the fall or winter, turning under all the manure that can be given. In the spring plant corn and, at the last working of the corn, sow peas broadcast; cut off the corn in September, plow under the peas, and give a top dressing of lime . . . and then sow and harrow in 5 to 8 pecks of wheat per acre. In February or March, following, sow 4 quarts of clover seed per acre. Harvest the wheat in June, and sow 1 bushel of plaster [white melilot?] per acre, and pasture lightly during the summer . . . . Manure is used, either upon corn or wheat ground, on such parts as require it most. But after the land is brought to that state, by means of the valuable system of plowing, manure, and lime, that it will produce a good crop of clover, Mr. B. [the planter] is sure of a good crop of wheat or corn, whenever required." Surely this rotation system, practiced 100 years ago on these North Carolina estates, is worthy of note today. And who wouldn't like to know what has happened to those thousands of acres through the century, and their condition today.

As a contribution to Americana the Solon Robinson volumes are important. For example, on the 11th of February, 1849, Robinson wrote from Plaquemine, La., for the Daily Cincinnati Gazette "Messrs. Editors: I am shut up—cabin'd—crib'd—confined—i. e. I am *located* just here while it may please heaven to grant a cessation to this outflowing, down tumbling, 2 days' shower. And unless you 'up-country folks' soon cease to send down your floods, wo be to this devoted land. What a satisfaction it would be now if we were all assured that we were born to be hung, for then we should feel safe; whereas the drowning prospect is just now much the strongest." There follows a vivid description of a lower Mississippi flood—steadily rising waters, flooded crops, "cholera times," the broken levee and towns and plantations under water, an icy wind from out the north and steamboats coated with ice. And then, the excitement of the flood past, in his zeal for soil improvement, a planter is commended for using bagasse from his sugar mill as manure, while in the same breath, so to speak, another planter who burns bagasse is "lashed" for being "still disposed to practice this method of destroying a valuable article for manure."

Robinson's account of the Great Poultry Show at Boston in November 1850 is a gem of humorous writing, while his Lecture on the Early History of Lake County, Ind., is probably one of the most vivid pictures of prairie agricultural pioneering that has come down to us from the covered-wagon era.

ECOLOGICAL ANIMAL GEOGRAPHY. By Richard Hesse, W. C. Allee, and Karl P. Schmidt. New York and London. 1937.

This is an authorized, rewritten edition in English, based on *Tiergeographie auf oekologischer Grundlage* by Professor Hesse of the University of Berlin. The volume makes accessible to students in America a great deal of European literature on zoögeography and has the added advantage of presenting ecological problems on a world-wide basis. The last chapter in particular, which discusses the effect of the rapid and recent advances of civilization upon primeval communities of plants and animals, is written from the American point of view and in the light of American experiences. The change in environmental conditions through deforestation, draining of swamps and marshes, irrigation, crop cultivation, etc., is pointed out in some detail to show the effect of man and his activities on animal communities.

Throughout the book emphasis is upon distribution of animal communities rather than vegetation or elements of the nonliving environment. In the main, the investigations are directly concerned with the adaptation of animals to their environment and the influence of environment upon the animals. The first part of the volume consists of studies of the ecological foundations of zoögeography including conditions of existence, environmental selection

and classification, barriers and means of dispersal, geographic isolation, historical accounts of the faunal regions of the earth, and extent of range. The remaining three parts treat directly and separately the composition of animal communities in marine waters, in inland waters, and on land.

Chapters having special interest for the conservationist are those dealing with animal communities in standing waters and other inland waters, forest communities, dry, open land habitats, swamp and shore dwellers, and alpine zones. The bibliography is unusually extensive and valuable to the student of ecological animal geography.

C. C. C. FORESTRY. Compiled by H. R. Kylie, G. H. Hieronymus, and A. G. Hall. United States Government Printing Office, Washington, D. C. 1937.

This is a very interesting book, well set up in the popular manner. It is recommended by the Woodland Management Section as valuable not only for C. C. C. boys but for all members of the Service. We are told also by the foresters that it has the great advantage of having been compiled by men who have made no technical errors—a feature not always found in popular manuals. The volume is richly illustrated throughout with photographs, charts, and marginal pen-and-ink sketches. The sketches are particularly pleasing as they are well designed and arranged to interest and instruct readers who are not equipped with the technical background necessary to the intelligent study of most books on forestry.

The text is divided into 14 chapters and presents in a simple manner the approved practices for forest conservation and forest utilization. The appendix contains a cross reference guide to be used with C. C. C. Vocational Series No. 8, a list of 100 important trees in the United States and their ranges, and a glossary of forestry terms. It is the opinion of the reviewer that this book would be very valuable to farmers owning woodlots as well as to the C. C. C. enrollees and conservationists.

620 MILES OF CONTOUR FURROWS

(*Continued from p. 177*)

second, to speed up the stabilization of the entire watershed; and third, to form windbreaks to aid in holding snow on the area.

A severe test of the furrows came within a year after construction was started. Torrential rains fell on the Pocatello area, amounting to more than 2 inches in less than a 24-hour period. There was no flood from the portion of the watershed that had been treated. On an adjacent untreated watershed run-off was heavy, carrying debris into the city and washing out a short section of street to a depth of 8 feet. Moisture penetration 3 days after the rain was 7 to 10 inches on the areas between furrows, and 16 to 24 inches in the furrows.

SYNTHETIC GROWTH SUBSTANCES

(*Continued from p. 199*)

but one of the various essential factors in plant growth, the rapid development of this new field is revolutionizing plant physiology. For the first time logical and demonstrable explanations of some hitherto puzzling types of plant behavior can be made. That these phytohormones now happen to have an immediate practical application is a fortunate accident. The past history of science has shown that knowledge which is of very little value at the time of its discovery may have valuable practical applications later.

BASIN LISTING

(*Continued from p. 200*)

tained emphasize the important role played by vegetative cover in conserving snow moisture. About 8 percent increase in moisture penetration resulted from basin listing, as compared with the untreated land.

It should be repeated here that the greater amount of penetration in cornland over that in grain land was due to a difference in moisture reserve in the fall. Last summer and fall the soil moisture from rain in thistle fields was quickly depleted, but in the cornfields the moisture reserve increased appreciably toward the end of the season.

The results obtained indicate that considerable moisture from snow may be conserved by fall listing on land devoid of vegetative cover. On land having vegetative cover very little additional moisture can be saved by listing, providing slopes are not excessive and the soil at the proper time is in condition for absorption. Basin listing is more effective in the conservation of snow moisture than ordinary listing.

Contour Listing of Corn

Some of our projects in the Corn Belt have introduced listers, and many of the farmers have listed their corn on the contour. The results secured are surprising, as on many farms much better yields are obtained from the listed corn than from adjoining checkrow plantings. Such objections as crooked rows, point rows, difficulty in controlling weeds, and others raised by the farmers, seem to disappear when contour listing is given a trial.

TENTATIVELY SCHEDULED

February—Special Research Issue.
March—Special S. C. S.-C. C. C. Issue.

U. S. GOVERNMENT PRINTING OFFICE: 1938

A New List of Recent Publications for Service Use

For REFERENCE

Compiled by Mrs. ETTA G. ROGERS, Publications Unit

Field offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

Soil Conservation Service

Advance Report on the Sedimentation Surveys of Lakes Crook and Gibbons, Paris, Tex. February 27–March 27 and March 25–31, 1936. mm. SCS-SS-17. October 1937.

Advance Report on the Sedimentation Survey of Ottawa County State Lake, Bennington, Kans. March 23–April 13, 1937. mm. SCS-SS-18. November 1937.

Office of Information U. S. Department of Agriculture

Artificial Drying of Forage Crops. Circular 443. Bureau of Agricultural Engineering. August 1937.

The Nichols Terrace: An Improved Channel-Type Terrace for the Southeast. Farmers' Bulletin 1790. Soil Conservation Service. October 1937.

Conserving Corn Belt Soil. Farmers' Bulletin 1795. Soil Conservation Service. November 1937.

A Graphic Summary of Farm Machinery, Facilities, Roads, and Expenditures. Miscellaneous Publication 264. Bureau of Agricultural Economics. July 1937.

Soil Survey Manual. Miscellaneous Publication 274. Bureau of Chemistry and Soils. September 1937.

Soil Conservation Districts for Erosion Control. Miscellaneous Publication 293. Soil Conservation Service. October 1937.

The Farm Outlook for 1938. Miscellaneous Publication 298. Bureau of Agricultural Economics. November 1937.

Rate of Flow of Capillary Moisture. Technical Bulletin 579. Bureau of Agricultural Engineering and Oregon Agricultural Experiment Station. October 1937.

Sources of Moisture for Precipitation in the United States. Technical Bulletin 589. Soil Conservation Service. October 1937.

Agricultural Experiment Stations

Alkali Soils: Origin, Examination, and Management. Circular 292. Agricultural Experiment Station, Berkeley, Calif. June 1925, revised July 1937.

Chemical Composition of Soils of Texas. Bulletin 549. Agricultural Experiment Station, College Station, Tex. July 1937.

A Description of the Agriculture and Type-of-Farming Areas in Texas. Bulletin 544. Agricultural Experiment Station, College Station, Tex. June 1937.

Economic Benefits of Irrigation from the Kingsley (Keystone) Reservoir. Bulletin 311. Agricultural Experiment Station, Lincoln, Nebr. October 1937.

The Economic Implications of the Crop and Livestock Adjustments in the Crooked Creek Erosion Control Project, Indiana and Armstrong Counties, Pennsylvania. Agricultural Experiment Station, State College, Pa., in cooperation with the Soil Conservation Service and Bureau of Agricultural Economics, U. S. Department of Agriculture. mm. September 1937.

An Economic Study of Land Utilization in Steuben County, New York. Bulletin 674. Agricultural Experiment Station, Ithaca, N. Y. June 1937.

An Economic Study of Land Utilization in Rensselaer County, New York. Bulletin 675. Agricultural Experiment Station, Ithaca, N. Y. June 1937.

The effects of Certain Lime Materials on the Leachings from Frederick Silt Loam Soil. Technical Bulletin 61. Agricultural Experiment Station, Blacksburg, Va. September 1937.

Fertility Losses from High Plains Soils Due to Wind Erosion. Panhandle Bulletin 63. Panhandle Agricultural Experiment Station, Goodwell, Okla. September 1937.

The Liberation of Plant Nutrients from the Soil as Affected by Alfalfa. Technical Bulletin 60. Agricultural Experiment Station, Blacksburg, Va. August 1937.

Liming Kansas Soils. Circular 185. Agricultural Experiment Station, Manhattan, Kans. September 1937.

Loss of Plant Nutrients from Peat Soil. Memoir 206. Agricultural Experiment Station, Ithaca, N. Y. July 1937.

Marshall County Soils. Soil Report 59. Agricultural Experiment Station, Urbana, Ill. June 1937.

1938 Agricultural Outlook for Georgia. Bulletin 463. Agricultural Extension Service, University of Georgia, Athens, Ga. November 1937.

Pastures for Georgia. Bulletin 457. Agricultural Extension Service, University of Georgia, Athens, Ga. Revised October 1937.

A Preliminary Report of a Study of Strip Cropping in Belmont County, Ohio. Ohio State University, Columbus, Ohio, in cooperation with the Soil Conservation Service and Bureau of Agricultural Economics, U. S. Department of Agriculture. mm. September 1937.

Putnam County Soils. Soil Report 60. Agricultural Experiment Station, Urbana, Ill. July 1937.

Results of Experiments, 1931–1936. Experimental Sub-Station, Beaverlodge, Alberta. Dominion Experimental Farms, Department of Agriculture, Dominion of Canada, Ottawa, Canada. 1937.

Soils in Relation to Fruit Growing in New York. Part XI: The Organic-Matter Content of New York Orchard Soils in Relation to Orchard Performance. Bulletin 672. Agricultural Experiment Station, Ithaca, N. Y. June 1937.

Sorghums Varietal Tests in Utah. Bulletin 281. Agricultural Experiment Station, Logan, Utah, July 1937.

Soybean Production in Michigan. Circular Bulletin 161. Agricultural Experiment Station, East Lansing, Mich. June 1937.

Soybeans for Grain. Circular 373. Agricultural Experiment Station, New Brunswick, N. J. July 1937.

Strip-Cropping in Northern West Virginia as Practiced Voluntarily by Farmers in Marshall, Ohio, and Brooke Counties. Circular 24. Agricultural Experiment Station, Morgantown, W. Va., in cooperation with the Soil Conservation Service and Bureau of Agricultural Economics, U. S. Department of Agriculture. mm. November 1937.

Studies on Soil Structure: Some Physcial Characteristics of Puddled Soils. Technical Bulletin 67. Agricultural Experiment Station. Tucson, Ariz. June 15, 1937.

A Study of the Operation of the 1936 Soil Conservation Program in Vermont. Bulletin 413. Agricultural Experiment Station, Burlington, Vt. March 1937.

Trees, Shrubs, and Vines at the North Platte Experimental Substation. Bulletin 310. Agricultural Experiment Station, Lincoln, Nebr. July 1937.

Using the Tractor Efficiently. Bulletin 343. Pennsylvania State College, State College, Pa. April 1937.

West Virginia Pastures: Type of Vegetation, Carrying Capacity, and Soil Properties. Bulletin 280. Agricultural Experiment Station, Morgantown, W. Va. June 1937.

Miscellaneous

Progress Report, National Resources Committee, October 1937. 1937. 10¢ from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

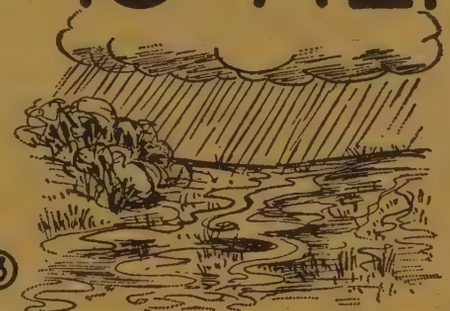
Selected Bibliography on Erosion and Silt Movement. U. S. Geological Survey Water-Supply Paper 797. 1937. 15¢ from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

Soil Erosion Control with Austin-Western Terracers, Blade Graders, Elevating Graders, Trailbuilders, Rip-Rooters, Scrapers and Plows. Bulletin 1383. Austin-Western Road Machinery Company, Aurora, Ill.

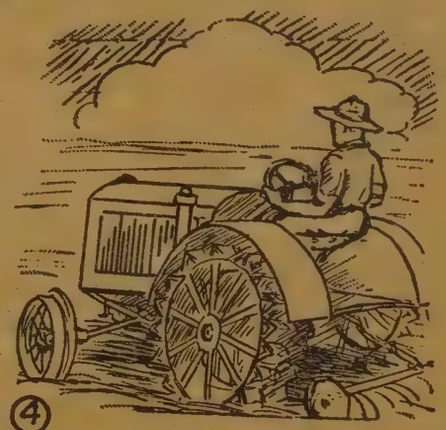
THE SOIL IS ALIVE

① The soil is a living system able to supply food in available form to crops.

② For every animal and plant on the earth's surface, there are hundreds in the soil—Micro-organisms.

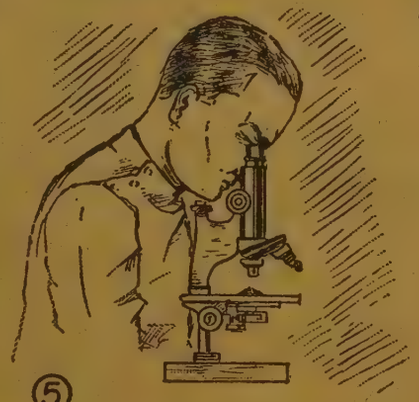


③ A slimy substance produced by micro-organisms helps prevent erosion by binding the soil.



④ Their production of carbon-dioxide keeps heavy soil friable—thus favorable to the cultivator and plant growth.

These soil microbes may thus be truly considered as the greatest friends man has on this earth. Without them life would soon come to a standstill.



⑤ Micro-organisms absorb large amounts of plant nutrients thus preventing leaching out of these essential elements.

⑥ Decomposition of micro-organisms frees nutrients back into circulation, thus serving as a storehouse for plant food.

⑦ Micro-organisms play an important role by disintegration of stubble, leaves, animal residues and kitchen waste.

⑧ The soil's animal population varies from microscopic protozoa to large earth worms. These aid in mixing the soil.

[This presentation is based on Dr. Waksman's article "The Living Soil" in this issue.]

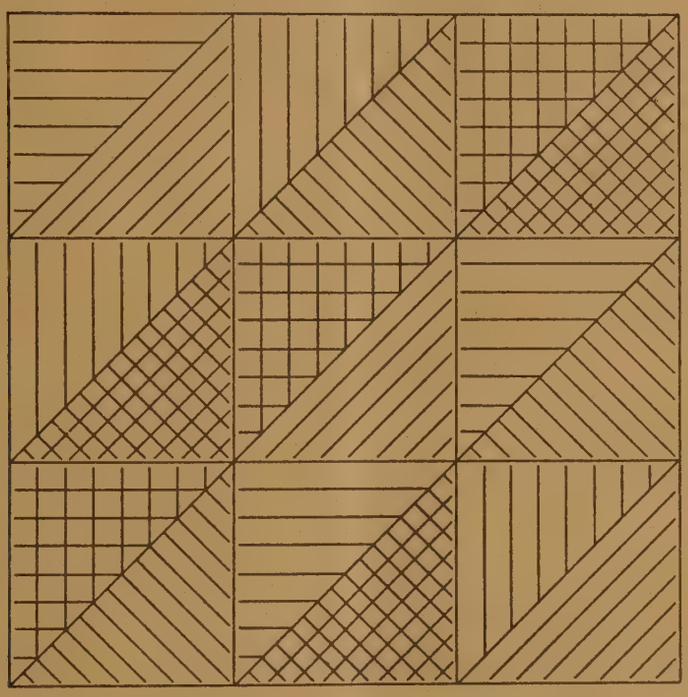
So35

OIL CONSERVATION

FICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
IITED STATES DEPARTMENT OF AGRICULTURE · WASHINGTON

Cop 2

U. S. F. S. RECEIVED
LIBRARY
FEB 16 1938



GRECO-LATIN SQUARE
for setting up experimental plots

—See p. 210

EBRUARY SPECIAL RESEARCH ISSUE 1938

Contents

	Page
A Challenging Field for Research: *By James T. Jardine*	203
Research in Soil Conservation: *By W. C. Lowdermilk*	204
Size and Shape of Control Plots for Run-off Studies: *By A. E. Brandt*	209
Field Research Offers Significant New Findings: *By G. W. Musgrave*	210
Hydrologic Investigations on Selected Watersheds: *By C. E. Ramser*	215
Relation of Sedimentation Studies to a Flood-Control Program: *By G. C. Dobson*	219
Economic Implications of a Soil and Water Conservation Program: *By Walter J. Roth and Alexis N. Garin*	223
Recent Achievements of the Section of Climatic and Physiographic Research: *By C. W. Thornthwaite*	226
The Soil-Saving Persimmon: *By S. B. Detwiler*	230
Preliminary Notes on Reservoir Studies in the Great Plains States: *By Mark P. Connaughton*	232
Book Reviews and Abstracts: *By Phoebe O'Neall Faris*	234
For Reference: *Compiled by Mrs. Etta G. Rogers*	Opposite 234

ACKNOWLEDGMENTS: To Dr. W. C. Lowdermilk, chiefly responsible for the gathering of material for this Special Research Issue.

APOLOGIES: To the several able contributors whose papers, because of Soil Conservation's physical limitations, must await publication at a later date.

SOIL CONSERVATION is issued monthly by SOIL CONSERVATION SERVICE of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. SOIL CONSERVATION seeks to supply to workers and cooperators of the Department of Agriculture engaged in soil conservation activities, information of especial help to them in the performance of their duties, and is issued to them free by law. Others may obtain copies from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of $1.00 per year, domestic; $1.40 per year, foreign. Postage stamps will not be accepted in payment.

WELLINGTON BRINK
EDITOR

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

VOL. III • NO. 8

H. H. BENNETT
Chief, Soil Conservation Service

FEBRUARY • 1938

ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON

A Challenging Field for Research

By James T. Jardine [1]

RECENTLY public attention has been called forcefully to the wastage of our soils through erosion. It may be surprising to some of us that so little thought was given to this problem in the past; yet it is not so surprising when we realize that this is a relatively new country in which land, for the most part, has been both abundant and cheap. In the exploitation of soils and the subsequent endeavor to redeem them, we are merely repeating history. Perhaps we of this country are somewhat exceptional, however, in that we are beginning in time to save our soils and are invoking the forces of science to help us.

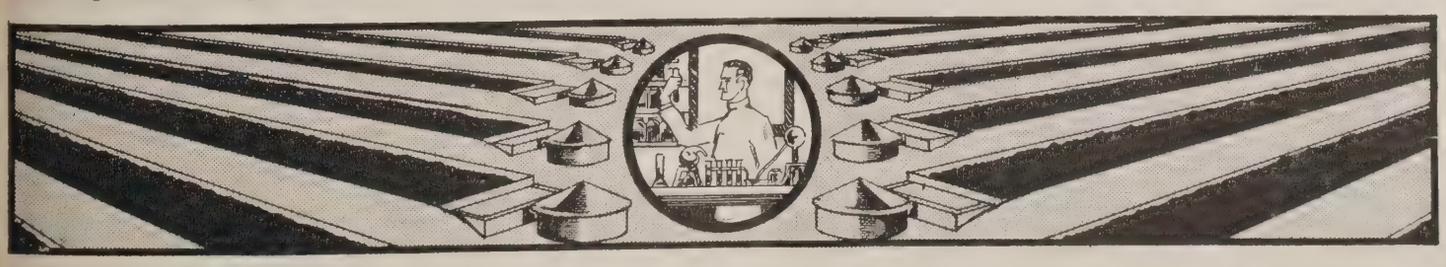
The Division of Research of the Service is fortunate indeed that it does not have to begin its studies from "scratch," as the Department of Agriculture and the State stations had to do some 50 years ago. Since that time, the sciences have become effective tools for the solution of agricultural problems, and satisfactory forms of research organization and administrative policy have been evolved. By the application of the sciences in State and Federal research agencies, much has already been learned about soils and their utilization in crop and livestock production. While earlier research may not have been specifically designed to solve the problems of erosion control, much of it throws light upon the problems involved. These studies have yielded valuable information concerning the nature of soils, soil fertility, plant foods, plant food requirements, and the entire matter of crop and livestock farming.

The task before the research workers therefore is simplified by the research that has gone before. Their commission is to plan and conduct new research especially designed to develop erosion control practices and in so doing to coordinate their efforts with the other research agencies, State and Federal, the work of which has much to contribute to the solution of erosion control problems. The soil conservation research specialists thus become analysts and synthesists of research efforts and results in many fields and subfields. For example, 10 years' results from a dozen soil erosion experiment stations, combined with the physical and biological knowledge already accrued for agriculture, gave the Soil Conservation Service a preliminary basis for its operations and extension activities.

The cooperative relations established by the Soil Conservation Service with other Federal agencies and the State Agricultural Experiment Stations thus become obviously a most effective means of attaining the objectives of the Research Division. Through such relationships, the research forces of the Service will have available the benefits of practically all the agricultural research talent of the country.

Soil conservation research specialists are challenged therefore; and the answer to the challenge calls for the visualization of the more outstanding problems to be found in the field and the capacity to enlist the services of both State and Federal research agencies in a broad effort to discover and assemble a body of knowledge adequate to the control of erosion as it bears upon the conservation of soils and soil fertility.

[1] Director of Research, and Chief, Office of Experiment Stations, U. S. Department of Agriculture, Washington, D. C.



Research In Soil Conservation

By W. C Lowdermilk [1]

Extremes in land use are represented in the three pictures on these two pages.

The aerial view above is of a Southern farm entirely shorn of its productive capacity—a scene of utter ruin and desolation resulting from an exploitative system.

Opposite, at the right, is bench terracing on mountain slopes in Peru. Built long before Columbus discovered America, still extensively in use, this terracing represents an original investment of human labor equivalent to $18,000 to $35,000 per acre and is indicative of the lengths to which a people will go to survive.

The third picture, taken in Wisconsin, represents a logical and constructive transitional stage between an exploitative and a permanent agriculture. It shows practices designed to reduce soil wastage which are less elaborate but economically justified under conditions prevailing in many parts of the United States.

PHYSICALLY, land use is conditioned essentially by three major factors, namely, (*a*) needs of plant and animal products, (*b*) soil productivity, and (*c*) integrity of the soil resource.

The need for food and other products rises with advance in social development from a subsistence requirement to levels of economic demand. But economic demands, throughout such development, are relative in place and time. The satisfaction of the primary demand for food becomes in modern society a commercial objective for supplying an economic want. The continued satisfaction of wants, whether subsistence or commercial, is conditioned, moreover, by the other two factors of land use.

In the second place, land use responds to the relative and absolute productive capacity of soils. Under natural conditions the store of plant nutrients is main-

[1] Chief, Division of Research, Soil Conservation Service, Washington, D. C.

tained, at least approximately, by the balancing of losses through leaching with increments. Such increments in the natural state occur in dust, rainfall, in the decomposition of plant debris, in the release of nutrients through weathering of fresh soil material and rock, in overwash, and in the fixation of nitrogen by bacteria. Under use, however, certain critical elements such as nitrogen, phosphorus, potassium, and calcium are removed in harvested crops. Soil management under otherwise favorable conditions becomes a simple business transaction whereby the differential in removal of nutrients is replenished by leguminous crops and by commercial fertilizers. Yet this transaction of the soil cannot last long unless the physical body of the soil resource is maintained.

The integrity of the soil resource is the third basic factor of land use. Until recent years it has been too much overlooked. Maintenance of physical integrity

of the soil resource accordingly requires special attention and investigation; it is fundamental in the conservation and sustained utility of the soil and waters of the land. Such maintenance rests upon an accurate diagnosis of the effects of present land use from problem area to problem area and the discovery of safe limits in uses of land.

Not only does the physical integrity of the soil hold the fate of agricultural production, but it holds as well the fate of the distribution of precipitation waters and the production and accumulation of erosional debris. The destruction of the physical body of the soil resource sets in motion a train of events, social, economic, and physical, which affects not only agricultural production but flood flows and the utility of water resources.

Upon this three-footed base land use would appear to rest. All factors are interrelated, but safeguarding the physical integrity of the resource with its direct and indirect influences becomes a primary requisite in long-range conservation of land resources.

Function of Research

Research in soil conservation involving causes and control of erosion must begin with the soil resource, including the normal processes of its formation and removal and its interrelations with plant and water resources. It must, thereupon, explore the nature, causes, extent and effects of soil and water wastage under necessary agricultural pursuits. It must determine and test fundamental, practical and economically feasible means of conserving the resource by preventing undue wastage and by restoration of these resources incident to needful and sustained land use. It must bring to bear upon the problems involved several fields of science and practice and call into effective cooperation the agencies concerned with these special fields; it must develop in cooperation with State agricultural experiment stations a forward-looking program of needed basic and applied research by States and problem areas. It must plan and carry out in cooperation with State agricultural experiment stations and other appropriate scientific and technical agencies, essential projects of basic and applied research. It must take part in fitting the findings of research to the land in accord with its needs and adaptabilities on operations projects as proving grounds, in cooperation with field and technical organizations. It must further provide, in cooperation with State agencies, for adequate basic and applied research on the effects of land use on water resources, stream flow, and flood flows as influenced by rates and amounts of storm run-off, by detention storage, and by the accumulation of erosional debris. It must determine, in collaboration with appropriate agencies, the economics of erosion and of its control from the viewpoint of the farmer as well as from that of the community and the public.

In fulfilling these functions, research must serve the present and future needs of farmers and of land-use agencies and contribute to the planning for sustained land use by furnishing the specialists of the Soil Conservation Service engaged in work on the land, and other agencies, tested and reliable information on, as well as criteria for, measures and practices of soil and water conservation. The research function embodies the role of the prophet.

Correlation of Functions

Research in soil conservation is organized to conduct basic investigations responsive to the needs of science and practice. It is conducted as a cooperative enterprise with State agricultural experiment stations as State headquarters and in field stations as centers of work for problem areas. Investigations include (*a*) exploratory studies, (*b*) basic reasearch, and (*c*) field tests. Exploratory studies serve to evaluate going measures and practices and to point up questions which require answer and problems awaiting solution. In some cases field studies may suffice to yield satisfactory empirical answers ready for immediate application. In any case, they point up the questions or problems to be referred to soil conservation research laboratories or field stations for thorough study. Such basic investigations at cooperative field stations and laboratories will be carried as far as necessary in fundamental research to reach satisfactory solutions. In turn, the findings of research are applied in field tests cooperatively on field projects and conservation districts or other areas so as to fit the findings to the land, problem area by problem area. Such correlation of the functions of research and work on the land in the field laboratories and project areas assures reponsiveness to the needs of field practice as well as to requirements of scientific investigations.

Since erosion, together with the processes which it releases, is a complex phenomenon, its character and trends must be fully identified. As a geologic process, erosion is older than sedimentary rocks; it has sculptured landscapes and supplied materials for vast sedimentary deposits. Yet within regions enjoying a climate that supports a complete coverage of vegetation, this geologic erosion has not normally gone on faster than soil formation. Under such conditions, soils and natural vegetation have developed inter-

dependently through thousands of years. On the other hand, when the natural coverage of vegetation is removed by whatever cause, soils are bared, as never before, to the direct action of wind and flowing water. Erosion of an entirely different order, man-induced and accelerated, is thus introduced by agricultural operations. This soil erosion proceeds generally faster than soil formation, and unless controlled and prevented, condemns the soil to less productive uses or to serious depletion. Accordingly, the causes, character, and prevention of soil wastage by erosion, under necessary use for crops and livestock, and resultant disturbance in the regimens of water run-off, are conditioned by a complexity of environmental factors. Research in soil and water conservation consists in the analysis and synthesis of a number of fields of science in the interests of the farmer and agriculture. It must provide for meeting the hazards of use, but also for improvement of production under use, and for the restoration of depleted soils. Employing as it does specialists in a variety of fields, and involving several methods, research in soil and water conservation raises a challenge in coordination and synthesis which the Division of Research has accepted. The six sections of the Division are set up to divide the field systematically and to cover it adequately.

Organization of Division

To provide for adequate direction of the various phases of soil conservation research, and to give latitude and initiative to outstanding specialists, the Division is organized into six sections, each having a well-defined subject-matter responsibility and headed by specialists in their respective fields. The work of the sections is coordinated within the Division and correlated with the land action programs of the Service, and with scientific bureaus and other agencies. A brief description of the field of each section follows:

1. Investigations of the Principles Involved in Soil and Moisture Conservation and Methods for Their Practical Application on Agricultural Lands [2]

The object of the work under this section is to discover, to develop, and to test principles, measures, and practices in the agricultural uses of land which are necessary to conserve the integrity of the soil resource. The investigations include the development of effective and economical methods and practices for conserving soil and water under actual farming conditions. This calls for the testing of combinations and integrations of erosion control measures in different climatic regions with varied soils and sites, thereby determining the relative effectiveness and practicability on the farm of different practices or combination of practices. Field stations and State experiment station laboratories serve as centers of work for represented problem areas.

2. Watershed Investigations of the Effect of Land-Use Practices on Run-Off as Related to the Methods of Control of Erosion and Floods [3]

The objects of investigations under this section are to provide for the evaluation of the influences of land-use practices on storm run-off, stream flow, soil loss, and flood flow as affected by topography, shape, and size of drainage area, vegetative cover, surface and underground storage, tillage methods, and various erosion control practices, and to furnish information for the economic design of more effective erosion and flood control structures. Field stations and laboratories serve as centers of investigations for areas of similar hydrological characteristics.

3. Investigations of Sedimentation Resulting from Erosion [4]

The objects of investigations under this section are to furnish information on the damage done by accumulations of erosional debris and by sediments as well as the magnitude of potential damage to be expected if present land-use practices continue; to provide a measure of the relative needs of the different watersheds for erosion-control and readjustments in land use from the standpoint of protecting developed water storage, flood control improvements, and investments in agricultural land subject to damage from overwash of debris. Surveys and special laboratories serve for investigations on silting and the dynamics of silt-laden waters.

4. Investigations of Geographic and Climatic Factors Related to Erosion [5]

The object of investigations under this section provides for the determination and evaluation of the climatic factors causing regional differences in erosion and the interrelation of these factors with plant associations, topography, soil, and rock materials as they affect soil and water conservation practices; involving erosion history, the influence of erosion on ecologic changes of plant cover, physiographic research of

[2] See Field Research Offers Significant New Findings, by G. W. Musgrave. P. 210.

[3] See Hydrologic Investigations on Selected Watersheds, by C. E. Ramser. P. 215.

[4] See Relation of Sedimentation Studies to a Flood-Control Program, by G. C. Dobson. P. 219.

[5] See Recent Achievements of the Section of Climatic and Physiographic Research, by C. W. Thornthwaite. P. 226.

normal geologic erosion under various climates and topography and soil, and climatic research as it affects erosional processes. Field studies and surveys serve to supply data for laboratory and office analysis and reports.

5. Investigations of Erosion-Resisting Plants of Economic Value [6]

The object of investigations under this section is to find, test, improve, and develop economical methods of reproducing and utilizing specialized vegetative plants that are profitable in preventing soil erosion in different climatic regions. This provides for the development of a new supplemental system of permanent and profitable erosion-control farming and soil conservation practices in the United States applicable to sloping or erodible areas in which ordinary types of agriculture or reversion to natural vegetative cover are neither practical from a soil conservation standpoint nor profitable from the viewpoint of the landowner. Nurseries, field stations, and State agricultural experiment stations serve as the centers for hillculture investigations and tests.

6. Cooperative Investigations of Economics of Soil Erosion and Erosion Control [7]

The object of investigations under this section is to determine the economic effects of soil erosion and of soil conservation measures upon farm business and farm income and, furthermore, upon the community and social benefits as a basis for determining the distribution of the burden of soil and water conservation measures. These studies are conducted in cooperation with the Bureau of Agricultural Economics and economists at State agricultural experiment stations and projects of the Service.

The field organization includes all personnel of the Division engaged cooperatively with State agricultural experiment stations and other scientific and technical agencies and with field operations of the Soil Conservation Service, in formulating research programs and projects and in carrying out exploratory studies, research projects, and field tests in accordance with approved plans and projects.

The work of the Division is based upon a series of exploratory studies, research projects, and field tests dealing with specific problems which are being fitted into a forward-looking and integrated program of research. The research projects now in progress within a State, together with those subsequently developed, constitute a State program of soil conservation research. The State programs together with studies established in consultation with the National Research Council and other agencies in turn become a national program of research in soil and water conservation.

[6] See The Soil-Saving Persimmon, by S. B. Detwiler. P. 230.

[7] See Economic Implications of a Soil and Water Conservation Program, by Walter J. Roth and Alexis N. Garin. P. 223.

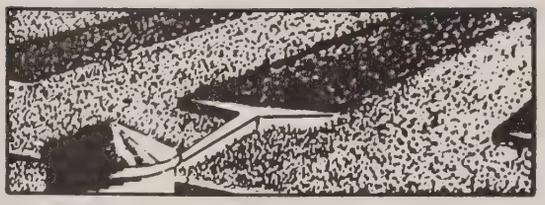
Preparing a State Program

In accord with the Memorandum of Understanding between the several States and the Soil Conservation Service, all research undertaken within a State by the Service will be in cooperation with the State agricultural experiment stations. Thus, the State becomes the unit in the formulation of the research program which must serve not only the immediate needs of the erosion control activities of the Service but also the agriculture of the State, of the problem areas which extend beyond State boundaries, and of the Nation as a whole. The work of the Division of Research is therefore a cooperative enterprise with the several States participating through their respective experiment stations and other research institutions.

The procedure for setting up programs of research necessarily must vary somewhat from State to State, but in every case three steps are involved. The first step is a study of the soil and moisture conservation problems of the State, the second a survey of the research work now in progress, and, third, the programming of the research necessary to meet the needs of a sustained land-use program. A schedule of needed research projects arranged in order of their importance will serve as a guide for the development of detailed work projects and the assignment of personnel. The rate at which the work can be undertaken will be determined by the funds available to the cooperating agencies and by the available personnel and facilities.

In the following pages are set forth some of the activities of workers of the Division of Research. These papers may serve to give some idea of the nature and scope of integrated investigations in the vital problems of land use and principles of the conservation of the soil, of conditions of soil productivity, and of utility of water resources which arise from the falling of rain and snow upon farm fields, pastures, wooded lands, and forests. The fate of a farm and the welfare of the farmer is tied up in the fate of the raindrops that fall upon his fields; in very truth the destiny of a civilization is inseparably linked with the fate of drops of rain and grains of soil under the action of wind and water.

Size and Shape of Control Plots for Run-off Studies



By A. E. Brandt [1]

AN OLD problem in a new guise is now being faced by all research agencies using control plots to study run-off and soil loss either induced by the application of water to simulate rain or as a consequence of natural rains.

It is generally agreed that the results obtained from field experiments with most plants may be influenced considerably by border effects. These border effects may be harmful in that the parts above ground compete for sunlight and those parts below ground for nutrients and water; or, on the other hand, they may be beneficial in providing protection from hot winds. The harmful effects can be eliminated by harvesting the crop or by making the necessary observations in such a manner as to exclude from the experimental results the observations on the borders. The portion of a field plot to be considered as border depends, among other things, on the height and density of growth above ground and the type of root system; but, as a rule, this must be determined by experimentation.

In control plot investigations as now carried on by the Soil Conservation Service it is not possible to measure the run-off and soil loss from various portions of the width and discard the information for the border portions. In order that the water which runs off the surface of an experimental plot may be conducted to proper catchment basins or tanks for measuring and for determining the load of earth carried, side baffles of earth or other material such as metal must be provided. Evidence obtained from control plots now in operation leads one to believe that as the water runs down the slope there is undue concentration along the baffles which modifies the erosion pattern. It is possible that, in addition to affecting the erosion pattern, this concentration of water along the borders influences the loss of soil and water from the plot.

It is the general opinion, where the treatments or factors being investigated by means of control plots are such that the plots throughout the experiment are all of the same size and shape, that the border effect does not introduce a bias which will lead the investigator to conclude that treatment A is superior to treatment B when, in fact, the opposite is true. However, when factors such as grade and spacing, which are important in the design of terraces and strip cropping layouts, are being investigated by means of control plots, the plots will of necessity differ in size in the same experiment.

The importance of the effect of the concentration of water in the border areas relative to the remaining area of the plot may, quite obviously, be reduced as much as desired by increasing the width of the plot. There are, however, certain factors in addition to border effects which must be considered when selecting the size and shape of plot to be used in an experiment, such as present knowledge concerning the subject being investigated, nature of the crop to be grown, purpose of the experiment, available facilities, and certain practical limitations.

On the basis of the present knowledge concerning the subject being investigated three classes of field experiment may be pointed out: preliminary or pilot experiments, critical experiments, and demonstration experiments. When a new line of investigation is opened up, a number of exploratory or pilot experiments are usually set up to find leads which will point the way for further and perhaps more precise study. In this preliminary or exploratory stage, as a general rule, only large differences are considered and large plots may be used and, in some instances, even replication is dispensed with, since the degree of precision need not be very high. In further following a lead provided by a preliminary experiment, smaller differences due to experimentally controlled variations of one or more factors will be encountered and more efficient plots must be selected to provide critical comparisons of one or more criteria. When a principle has been established by adequate experimentation, demonstration or extension experiments are sometimes set up to assist in spreading information regarding this principle. Since such experiments are arranged for exhibition, the experimentally controlled factors rarely ever are assigned to the plots at random and are seldom replicated.

Precise tests of significance are yielded only by critical experiments in which the experimental variants are properly randomized and replicated, but data from either of the other two kinds are frequently treated by statistical methods applicable to data from critical experiments only. It is seldom that the results of exploratory experiments are sufficiently precise to

[1] Senior mathematical statistical analyst, Division of Research, Soil Conservation Service, Washington, D. C.

serve as a valid basis for drawing definite conclusions except between widely differing treatments or practices. Strictly speaking, demonstration experiments are not experiments at all but oversimplified exhibits of experimentally established principles. Accidents of location, season, and various uncontrollable factors in demonstration experiments lacking proper randomization and replication may produce startling apparent differences and lead to erroneous conclusions. With a little explanation a properly designed critical experiment will serve very well for demonstration purposes and will not be as likely to mislead the casual observer.

The nature of the crop to be grown on an experimental area must be carefully weighed when an experiment is designed. Obviously a forest or orchard crop will call for larger plots than a close growing crop. Of the closer-growing crops, one grown in rows such as sugar beets, corn, or cotton, may require larger plots than small grains or grasses. Height of mature plant, rate of growth, susceptibility to shade, and type of root system are other natural variations which affect size of plot.

The last two named factors—available facilities and practical limitations—are so closely related that one might combine them. Of the facilities that might be limited, money, land, seed, and help might be mentioned. Experiments involving different methods of preparing the seedbed, of seeding or of cultivating the growing crop, may call for machines which will in a practical way determine the size of plot. The half-drill strip is an example.

For critical experiments, two types of design have proved to be efficacious. These are the Latin square and the randomized block. In the Latin square the plots should be as nearly square as possible, while in the randomized block design they should be long and narrow with the blocks as nearly square as possible. Since much of the experimentation in run-off and soil loss studies must be conducted on plots greater in one dimension, the Latin square design will seldom be used. It has been demonstrated through the utilization of data from uniformity trials, that plots should be as small as is possibly consistent with the factors discussed above. Smaller plots generally yield more information per unit area and are therefore said to be more effective.

In a Greco-Latin square (see front cover) there are two types of cross hatching (parallel to the sides of the squares and diagonal) and three kinds of each type used in this. The conditions for forming a Greco-Latin square require that one kind of each type shall occur once but only once in each row and in each column and that each kind of one type shall occur in a plot with each kind of the other type once but only once in the entire square.

Field Research Offers Significant New Findings

By G. W. Musgrave [1]

THE Section of Soil and Water Conservation Experiment Stations carries on its investigational program through field experiment stations located in various problem areas of the country, which are determined by prevailing soil types, weather conditions, topography, and agricultural practices. These field stations are cooperative with State agricultural experiment stations and serve as centers of investigations in erosion control and soil and water conservation for the problem areas represented.

At these field stations the nature and relationship of the basic factors affecting soil erosion are subjected to rigorous investigation. Measurements are made of the quantities of run-off and soil loss occurring under various field conditions for the purpose of determining the effects of these conditions on soil erosion and gully formation, and methods and devices for the control of erosion are developed.

A brief discussion of some of the more recent outstanding results of the work of the section follows:

Close Vegetation Reduces Rate of Run-off

A recent analysis of hydrographs made at the Clarinda and Bethany experiment stations, of run-offs from 50 storms of high intensity, shows that the average maximum rate of run-off from cornland on an 8-percent slope was two and one-half times greater than that from similar areas in clover and timothy. The extent of the effect of such close vegetation as bluegrass, Bermuda grass, alfalfa, and clover in reducing soil and water loss has been well established by research workers in soil conservation, but the extent of the effect of close vegetal cover upon rate of run-off is largely unknown. The effectiveness of vegetal cover

[1] In charge, soil and water conservation experiment stations, Division of Research, Soil Conservation Service, Washington, D. C.

in reducing rate of run-off has a very definite bearing upon the kind of control measures that should be used under certain conditions, as the successful use of strip cropping, terracing, contouring, and similar measures are dependent partly upon the rate of flow of run-off. The problem is important, furthermore, because of the fact that a retardation in rate of run-off is accompanied by far more than a proportionate reduction in amount of erosion.

The data included in the study reported cover the records of 3 years at one station and 5 years at the other under a wide range of rainfall and cover-crop conditions. During this entire period the only exception to the general result was from a storm producing run-off immediately after the plowing of corn ground. In this instance measurements showed that the plowing had loosened and fluffed up the soil to such an extent that the average land level was raised 2.4 inches. This provided additional pore space and probably accounted for the greater infiltration of water on the freshly plowed land than on the settled soil with close vegetal cover.

On Shelby loam, where the average amount of run-off from cornland from the 50 most intensive storms was 0.57 inch, the average rate of run-off was 0.67 inch an hour, or 2.5 times greater than the run-off from similar areas in clover and timothy. On this soil 24 of the 50 rains occurred during 3 years of a 5-year period. All 24 rains were relatively severe, but they were well scattered. For these rains the average maximum rate of run-off from corn was 0.91 inch an hour, or two and one-half times greater than that from clover and timothy, despite the fact that the hay crop was poor and averaged only 0.67 ton an acre. In general, similar results occurred on the Marshall silt loam. On both Shelby and Marshall soil the effect of vegetal cover in preventing run-off was demonstrated even when the soil was saturated

At left: A strip channel lined with Bermuda grass being tested at the Spartanburg outdoor hydraulic laboratory.

Below: This dam, built at the head of a rapid, creates a reservoir for the laboratory. The hillside downstream provides a good opportunity for experimental work.

with water and the amount of run-off from different kinds of covers was nearly the same. These results, developed by some of the most careful studies thus far conducted, indicate but one of the reasons why dense vegetation should be used wherever practicable.

Crops with Large, Dense Foliage Intercept Rainfall

Crops with large, dense foliage not only protect land from the force of beating rains but also intercept an appreciable amount of water with their leaves and stems. These effects were found in preliminary studies conducted at the Clarinda, Iowa, station in 1935, and were later enlarged upon in a carefully organized investigation requiring the development of special types of measuring equipment. The investigations included records from alfalfa, oats, corn, and soybeans throughout the growing season and from timothy, bluegrass, and wheat during part of the growing season. Intensity recorders were used so that not only the total amount of water reaching the surface of the ground beneath the canopy of a crop was measured but also the rate of fall. The figures obtained were compared with the amount and rate of rainfall that reached the surface of ground in the open. Devices were constructed so that the amount of water moving down the stems of some of the plants was measured separately from the amount that penetrated the canopy.

The studies showed that the interception of rainfall by the canopy of crops increases as the crops approach maturity, and that there is a direct increase in interception with increase in vegetative cover. For the rains which occurred in the 1937 season at Bethany, Mo., oats intercepted 7.2 percent of the total rainfall, soybeans 12.4 percent, corn 12.7 percent, and alfalfa 35.7 percent. The percentage of interception, of course, varies greatly with the intensity of the storms, and the figures cited for the 1937 season undoubtedly would differ for other seasons or other rainfall amounts, but they serve to indicate the wide differences which occur for different kinds of crops. During the month previous to their respective harvests, wheat intercepted 19 percent of the rain which occurred during the period, timothy 26 percent, and bluegrass 17 percent. The distribution of rainfall under the plants indicated that they tend to shed water toward their outer margins. It was found also that more rainfall reaches the ground on the windward side than on the leeward side of isolated plants. It was found furthermore that drilled crops tend to concentrate water in the spaces between rows. Thus, the study indicated that vigorous, well-nourished plants offer greater protection to land than plants of the same kind that are not thriving well; that the spacing of plants may have much to do with the degree of protection they provide; and that certain species, for example, alfalfa, are much more protective than others.

Organic Matter Increases the Permeability of Most Soils to Water

It is a matter of common observation that organic matter improves the physical condition of soil and promotes plant growth, but very few quantitative data are available on its effect on erodibility. Field and laboratory studies have therefore been conducted recently to determine the effect of organic matter on the erodibility of soil.

Samples of surface soil and subsoil from representative plots of the Dekalb, Upshur, Hagerstown, and Monongahela soils were given different organic-matter and lime treatments. A part of each sample was maintained under field conditions, while the other part was kept in the laboratory under optimum conditions of moisture and temperature. Determinations of the dispersion ratio and aggregate distribution of the samples were made 1, 3, and 5 months after treatment. Determinations of infiltration rate, organic-matter content, moisture equivalent, and volume weight and mechanical analyses were made at the end of the 5-month period.

Under field conditions there was a very significant increase in the rate of movement of water through the soil 6 months after treatment with organic matter. The average infiltration rates, in inches per hour, of the soils that had not been treated, as measured over a 2½-hour period following 48 hours after an initial 2½-hour run, were as follows:

Soil:	*Infiltration rate in inches per hour*
Dekalb surface soil	0.87
Dekalb subsoil	.90
Hagerstown surface soil	.91
Upshur surface soil	1.74
Monongahela surface soil	2.06

The infiltration rates of the same soils that had been treated with organic matter were:

Soil:	*Infiltration rate in inches per hour*
Dekalb surface soil	3.94
Dekalb subsoil	3.97
Hagerstown surface soil	1.89
Upshur surface soil	2.95
Monongahela surface soil	4.67

In the laboratory packed samples, which had a higher apparent specific gravity than the field samples, or-

ganic matter increased the rate of water movement very significantly in all soils except the Upshur surface soil and subsoil. Lime increased the rate of percolation in the Dekalb surface soil and subsoil, but caused a slight decrease in the Upshur surface soil and subsoil and in the Monongahela surface soil. Dekalb surface soil and subsoil treated with lime and organic matter together showed a very significant decrease in rate of percolation as compared with soil treated with organic matter alone, but a significant increase as compared with the untreated soil. The treatment of lime and organic matter in the Upshur surface soil and subsoil and in the Monongahela surface soil resulted in a rate of percolation slower than that of either the untreated soil or the soil treated with organic matter. The reasons for this decrease are not readily apparent, but the failure of organic matter to affect the water relationship and other physical properties of the Upshur soil was apparently due to the presence of a high percentage of active inorganic colloidal material. In all soils except the Upshur surface soil and subsoil there was a very significant decrease in the percentage of aggregates less than 0.05 mm in diameter, and an increase in the percentage of aggregates greater than 0.25 mm in diameter from applications of organic matter. The aggregating effect of organic matter was most evident in the silt loams low in active inorganic colloidal material and in organic matter.

The effect of organic matter on aggregate distribution and on dispersion ratio was practically the same 1 month and 5 months after treatment. It is indeed interesting that organic matter had so great an effect only 1 month after treatment. Whether or not any further effect on aggregate distribution by organic matter after further decomposition would be counteracted by increased dispersion because of higher temperatures and the drying of the soil is not definitely known. Organic matter decreased the apparent specific gravity because it lessened the weight per unit volume and caused aggregation of the finer soil fractions. The dispersion ratio was likewise decreased, but the moisture equivalent and the percentage of organic matter were increased.

With the samples collected from pasture plots located on Dekalb soils, fertilization had no significant effect on aggregate distribution or on dispersion ratio. The plots from which the samples were taken were located originally on old sod that was largely bare or covered with undesirable species. After 6 years the treated plots supported an excellent stand of bluegrass and white clover, whereas the untreated plots were still very poor. Grass seeded on intensively cultivated soil low in organic matter, however, would probably affect its physical condition favorably within a relatively short time. Comparison of the plots with adjoining pastures and cultivated fields on the same soil showed that cultivation had decreased the percentage of large stable aggregates very materially and increased the percentage of smaller sized aggregates. These data indicate that improving a poor pasture which has been in sod for many years may not materially change its physical condition.

It is logical to assume that a treatment that decreases the ease with which soil is brought into suspension and thereby lessens run-off, that clogs the pores of the soil and thus prevents infiltration of water, and that increases the number of large stable aggregates, total and noncapillary porosity, size of capillary pores, and infiltration capacity, will aid in the conservation of soil and water. The indirect effects of organic matter in erosion control, through stimulation of plant growth and consequent interception of the force of rain, and through the action of roots and worms in bringing about favorable structural conditions, are also important.

Testing Structures for Use Upon Farmlands

The ability of various kinds of erosion-control structures to withstand storms of 10-, 25-, or 100-year frequency may now be determined without awaiting the occurrence of such storms. This has been made possible through the ingenuity of the hydraulic engineers of the Section of Soil and Water Conservation Experiment Stations. It is now possible to obtain within a short time data that otherwise might have been collected only during a long period of years.

The behavior of various types of erosion-control structures has been studied under field conditions at the experiment stations for a number of years. Vegetated outlet ditches, channels of various kinds, small check dams, drop inlets, and similar structures have been installed for the purpose of determining their relative merits in erosion control. Under normal rainfall conditions, however, the structures may not be subjected to all the conditions necessary to obtain information for the safe and economic design of hydraulic works.

A program has therefore been initiated whereby control structures may be tested under all possible conditions. The work is being carried on principally at the hydraulic laboratory near Spartanburg, S. C., which is a small outdoor reservoir so located that water may be drawn from it along the upper side of a long steeply sloping hillside that provides suitable sites for structures under test. In the photograph

Gunny-sacks placed on top of dunes as wind deflectors. During one wind this dune was lowered 2 feet by this means; during another, 1 foot.

may be seen the dam that creates the reservoir and the hillside upon which the experimental work is conducted. The water supply of this reservoir has recently been greatly augmented, and flows as high as 50 cubic feet per second are now available. It is therefore possible to create for purposes of experimentation such conditions as would occur during critical storms. The results of this laboratory work will be correlated and compared with results occurring under comparable natural conditions as they occur.

Results of the tests that have been made show that Bermuda grass channel linings are extremely resistant to high velocities of flow. For short periods of time they will withstand velocities up to 8 feet per second without any permanent harmful effects. The illustration shows a steep channel lined with Bermuda grass over which a flow amounting to 1 cubic foot per second is running. Tests of vegetation for meadow strips seem to indicate that a good stand of Sudan grass will withstand velocities of 5 feet per second without undue harm, providing it is subjected to such velocities infrequently and for short periods only. Preliminary results indicate that first-year common lespedeza is more satisfactory in the protection of meadow strips than first-year lespedeza sericea, but that it is not as resistant to erosion as Sudan grass.

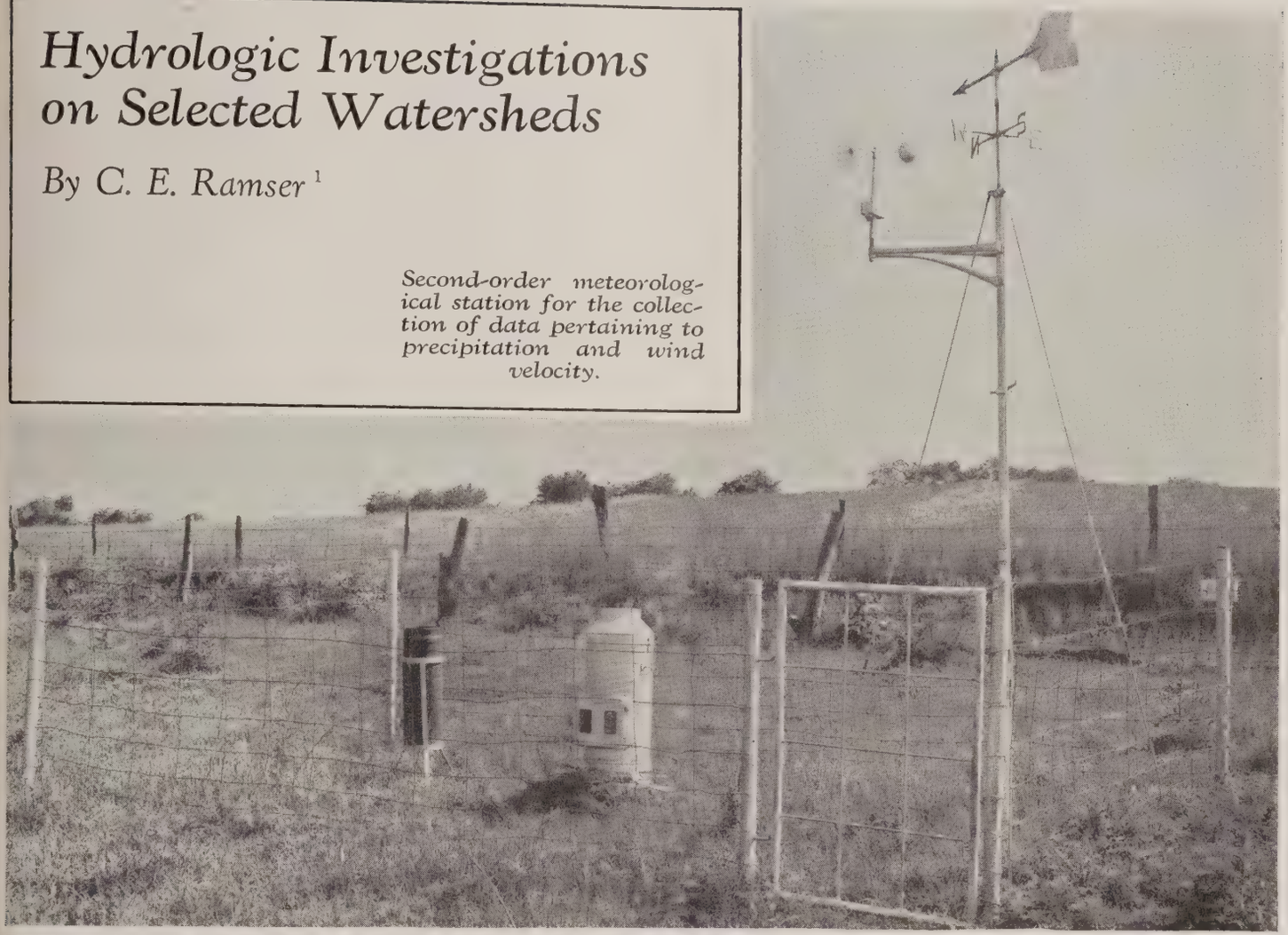
Studies of the water-carrying capacities of channels lined with vegetation showed that a notable reduction in velocity is brought about by vegetation. In shallow vegetated channels and meadow strips the value of Manning's n for depths of flow of about 6 inches was found to be about 0.05, whereas the corresponding value of Kutter's n is about 0.04. A full report on this significant study is being prepared for technical workers.

The new wind erosion station near Amarillo, Tex., has carried on a project in cooperation with the Division of Operations and the State experiment station to reclaim land that a year ago was a sand dune waste. This large area in the so-called "Dust Bowl" near Dalhart, Tex., had been so damaged by wind erosion in the blowing out and sorting of soils, with consequent formation of advancing sand dunes, that it was thought to have been virtually destroyed for further agricultural use. Furthermore, the advancing dunes were overwhelming good land lying in their paths. After a little more than a year of experimentation and application of research findings, splendid crops were produced upon this area. In the reclamation of mounting dunes the force of wind is utilized to level dune crests and redistribute the sand on the eroded land. The effect of wind jets was produced first by the setting on end of gunny sacks filled with sand at short intervals along the crests of dunes and then by gouging wind channels in the partially leveled dune areas. The spreading sand was caught in lister rows and stabilized by suitable vegetation. Measures were taken to conserve all available moisture within the tract. This work is described in more detail in the January issue of Soil Conservation.

As it relates to the Southern Great Plains area, this research project of sand dune reclamation, undertaken less than 2 years ago, is now completed. It has resulted in developing successful methods for reclaiming sand dunes, so that the methods may be prescribed and referred to the operations function of the Service for application on project areas.

Hydrologic Investigations on Selected Watersheds

By C. E. Ramser [1]



Second-order meteorological station for the collection of data pertaining to precipitation and wind velocity.

A SEARCH for available data needed in reporting on watersheds under the Omnibus Flood Control Act has disclosed a great lack of information relating to the influence of agricultural practices on water flow. This information is especially needed for carrying out those provisions of the act relating to the evaluation of land-use and soil conservation measures and practices in a national program of flood control. Under the act, the Department of Agriculture is called upon to report to Congress recommendations for measures and practices of land use and soil conservation which are justifiable in the interests of flood control and to supplement major engineering works in stream valleys.

Studies of the influences of land use on storm run-off, flood flows, silt production and water conservation are being conducted by the Section of Watershed and Hydrologic Studies. Such studies are planned to represent problem areas where soil and water conservation and flood control are inextricably related, and the problem areas will in time be located in a network of strategically placed experimental watersheds to serve as centers for land-use-hydrologic investigations. Thus far, three projects have been initiated, one within the Muskingum Conservancy District in Ohio, one within the Brazos River Reclamation and Conservation District in Texas, and one in the Central Great Plains.

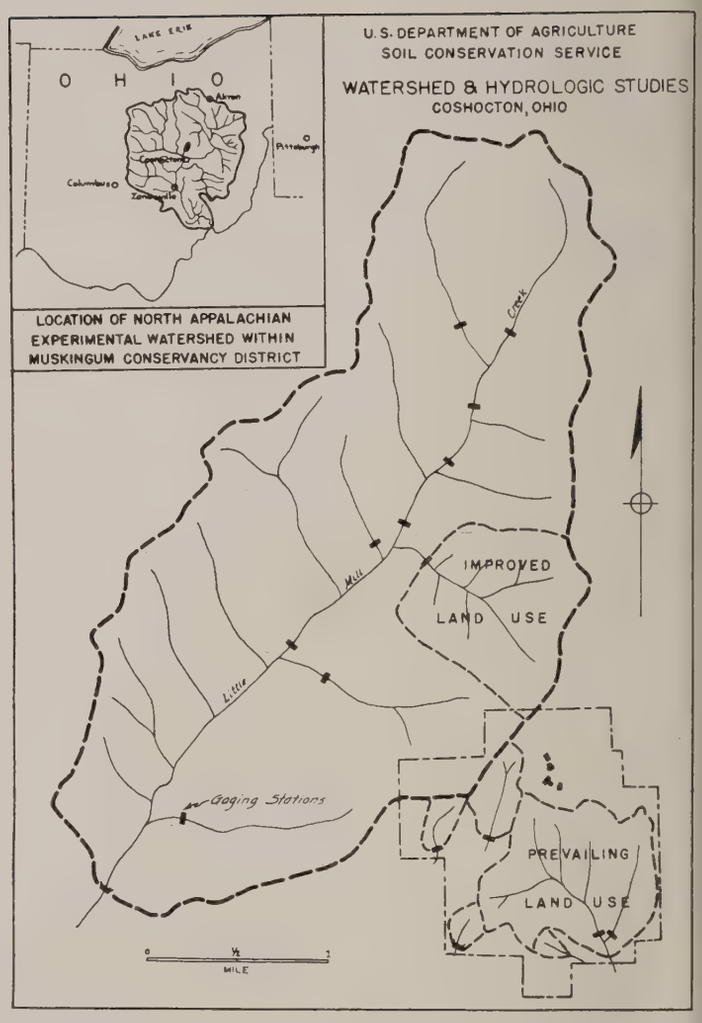
The Muskingum studies are being conducted in cooperation with the Ohio State Agricultural Experiment Station and the Muskingum Conservancy District. The Muskingum Conservancy District was formed for the purpose of providing protection against floods to the cities, towns, and farms lying in the valleys of the Muskingum River and its principal tributaries. With construction of flood-control reservoirs by the War Department and the Muskingum Conservancy District well along toward completion, it was particularly appropriate that the first project undertaken by this section should be representative of the North Appalachian hydrologic conditions and should lie in the heart of the Conservancy District. The district was quick to recognize the value of studies on the influences of land use on flood flows and silting, and the close cooperation is mutually advantageous.

[1] In charge, Section of Watershed and Hydrologic Studies, Division of Research, Soil Conservation Service, Washington, D. C.

The construction of 14 flood-control reservoirs by the United States Army Corps of Engineers for the Muskingum Conservancy District, at a cost of about $40,000,000, is nearing completion. The accompanying map of Muskingum Conservancy District shows the location of the reservoirs. Cooperative studies with the district have been initiated to extend the findings of the 5,000-acre experimental watershed to the 8,000-square mile watershed of the Muskingum Conservancy District.

All six sections of the Division of Research are taking an active part in the research work now under way and that contemplated, on the watershed of the Muskingum Conservancy District. The establishment of a network of self-recording precipitation stations, about 4 miles apart over the watershed of the Muskingum district, by the Section of Studies of Climatic and Physiographic Factors of Erosion, will furnish information relating to the storm pattern of all major storms over the watershed. This information will be indispensable in the study of routing flood flows, and of relations between peak stream discharges and intensities and amounts of rainfall over the watershed.

Measurements are made as well to determine the rate and amount of sedimentation in the reservoirs of the district for watersheds with controlled and uncontrolled land-use practices. Sedimentation measurements will be made in the reservoirs, at regular intervals, by the Section of Sedimentation Studies. The Division of Operations has established on the watershed of one of these reservoirs a project for the stabilization of the soil through improved land-use and soil conservation practices to be put into effect over the watershed draining into this reservoir.



In the preparation of a program for effective soil conservation practices to be employed over this watershed, the Division of Operations is guided by applicable experimental findings of the Section of Soil and Water Conservation Experiment Stations on the Soil Erosion Experiment Station at Zanesville, Ohio. The Section of Hill Culture Studies will work in cooperation with the Division of Operations, by employing certain shrubs and trees having a commercial value in the stabilization of the soil on certain areas owned by the Muskingum district. The district will also furnish information of general research value. Economic studies from the standpoint of land use, soil conservation, and flood control have been started by the Section of Investigation of the Economics of Soil and Water Conservation, on the 5,000-acre experimental watershed, and will be expanded to include studies in the Muskingum district relating especially to sedimentation of reservoirs and flood control.

These varied cooperative research activities will make the Muskingum Watershed Conservancy District the most complete flood control, land use, and soil conservation laboratory in the United States, if not in the world. No other research project has encompassed such a comprehensive program of research on a scale adequate to determine under reasonable control the influence of land use on storm run-off and flood flows. The findings of this undertaking will furnish reliable information on the influences of land use on flood control, silt control, and soil and water conservation, to serve as a guide in the planning, design, and financing of economic flood control projects in the future.

The first objective of the land-use-hydrologic studies is to furnish basic information necessary to a coordinated program of flood control for the safeguarding of agricultural lands and industrial and urban developments against flood damages. The Nation is committed to enormous expenditures for flood control; it is important that measures of flood control be complete and well coordinated, and take into account the factors which cause floods—from the fate of raindrops as they fall on the land until they have accumulated into raging flood flows in major streams.

In addition to problems of excess waters are those of insufficient waters. A knowledge of the influences of land use on water conservation, constituting the second objective, will furnish the basis for forward-looking land-use programs for the Great Plains drought area, as was reported to the President by the Great Plains Drought Area Committee. Crop losses experienced by farmers, not only in the semihumid but the humid regions of the United States during the past year, indicate the need for improved agricultural practices to conserve all available moisture for crops. Measures of erosion control tend to conserve moisture for crops, and it is essential that the effectiveness of these methods be ascertained in order to substantiate their adoption in a Nation-wide water conservation program. Also, a knowledge of the effect of land-use and soil conservation practices, on surface and under-

Strip-cropped field on the Coshocton experimental watershed project.

Foot bridge and cable station for making current meter measurements in open channels.

Typical watershed on Coshocton project, to be devoted to mixed land-use practices involving timber, pasture, meadow, and cultivated crops.

Parshall measuring flume and Ramser silt sampler used in measurement of run-off and soil loss from small watersheds.

ground water supplies for municipal, irrigation, and other purposes, is important in a program designed to work out the relation between these uses and the consumption of water by plants on watersheds. Such uses may in some instances be more or less conflicting. For example, surface water supplies for cities often command first consideration, calling on watershed management for maximum yields of water. On the other hand, land-use measures may reduce the water yield. Investigations are started in the Central Great Plains to determine what measures of land use can be recommended in the interests of sustained use of land and waters, to safeguard the soil as well as the utility of water resources.

The third primary objective of the land-use-hydrologic studies is to determine rates and amounts of run-off for the economic design of erosion-control structures and for related purposes. Run-off data are especially needed by operations projects of the Service. Run-off data are meager and inadequate for economic design for most erosion-control practices. For instance, the satisfactory design of notches for check dams, spillways, and drop inlet culverts, for soil-saving dams, channels, and outlet ditches for terraces, and diversion ditches for many different purposes—all of which are used in erosion control work—depend upon the availability of reliable run-off information from land areas. Structures may be underdesigned, resulting in failures, or overdesigned resulting in wasteful expenditures. Adequate run-off data should be used as the basis for all designs. The numerous failures, due to inadequate waterways for farm ponds, road bridges, culverts, and similar hydraulic structures are evidence of the lack of data on run-off.

Intensive studies designed to collect the foregoing information are being conducted on the watershed projects of this section. Detailed investigations are being made, on the experimental watershed projects, of the movement and action of water from the time it reaches the ground surface as precipitation until it leaves the watershed as surface or underground flow. These include studies of run-off and precipitation, percolation, and infiltration, evaporation, and transpiration, interception, surface, channel, and underground storage, and the movement of water over the ground surface and through stream channels. The part that these various factors play in the hydrologic cycle is graphically illustrated by the chart. Studies of precipitation relate to amount, intensity, duration, and areal distribution. A careful analysis is made of the physical characteristics of watersheds relating to soil and subsoil, topography, physiography, vegetative cover, geologic formations, and cultural factors, such as tillage and erosion-control practices.

The general plan of study includes: (1) the evaluation of all important factors by comprehensive experimental studies, and (2) tracing of the effect of these factors from small to large watersheds.

On the Coshocton, Ohio, experimental watershed project several batteries of in-place automatic recording water-cycle lysimeters have been built, to study the rate and amount relationships of rainfall, run-off, and percolation, and to evaluate evapo-transpirational losses.

Small watersheds of 1 to 10 acres will be used for experiments on the effect of erosion-control practices on the rates and amounts of run-off and soil erosion for rainfall of different amounts and intensities. Erosion-control practices to be used will depend upon their adaptability to the particular region. Some of these practices will be pasture, forest, cover and green manure crops, crop rotations, various tillage methods, strip cropping, and terracing.

Measurements of run-off and erosion on these small watersheds will be divided into two stages as follows: (1) For the purpose of determining the effect of inherent differences in the watersheds, due to influencing factors that cannot be readily evaluated, all the watersheds will be treated in a similar manner from the standpoint of cover. The duration of this stage will likely be 5 years or longer, depending on the normality of climatic and crop conditions during this period. (2) At the beginning of the second stage, the best erosion-control practices, as determined from the results of experiments at the soil-erosion experiment stations, will be established on a number of the small watersheds, and cropping and vegetative conditions on the other watersheds will continue, as during the first period, to integrate climatic conditions during the whole period of experimentation. The results of these experiments will give definite information on the effect of various erosion-control practices upon water conservation, storm and ground water run-off, and flood control. Many of these results will be indicated by trends that develop in the early years of the work.

Two rather similar watersheds of about 400 acres each have been selected on the Coshocton project for the purpose of conducting run-off and other investigations under present land-use practices. This will represent the first stage of the experimental studies. Afterward improved land-use and erosion-control methods will be put into practice on one of the watersheds, and the other of the two similar watersheds will

Relation of Sedimentation Studies To a Flood-Control Program

By G. C. Dobson [1]

THERE are in the United States more than 8,400 dams and reservoirs built at a cost of more than 2 billion dollars. This capital investment is depreciating by millions of dollars every year as a result of excessive silting caused by accelerated soil erosion. An estimate has been made,[2] on the basis of 81 reservoir surveys, that 38 percent of existing reservoirs in the United States will have a useful life of 1 to 50

(*Continued on next page*)

[1] Acting head, Section of Sedimentation Studies, Division of Research, Soil Conservation Service, Washington, D. C.

[2] Brown, Carl B. Rates of silting in representative reservoirs throughout the United States. Trans. Amer. Geophys. Union, 18th Ann. Meeting: pp. 554–557 (1937).

be continued under the same practices used during the first stage—this to obtain comparable data on the effects of improved land-use and erosion-control practices upon water conservation, run-off, and flood control for comparatively large areas.

In watersheds ranging in size from about 30 to 5,000 acres, information on rates and amounts of run-off and erosion from rains of different amounts, durations, and intensities will be collected to determine the effect of size of watershed on the rate and amount of run-off. Similar mixed land-use practices and erosion-control measures will be maintained on these watersheds so as to eliminate, as far as possible, any differences in run-off due to these practices.

At the outlets of all the watersheds, gaging stations are being constructed. On the smaller watersheds, the Parshall flume and other types of flume being developed will be installed; and on the larger watersheds, foot bridges and cable stations will be installed, in accordance with specifications of the United States Geological Survey, for making current meter measurements. The Ramser silt sampler will be employed for the measurement of soil losses from small watersheds, and a silt sampler is being developed in the hydraulic laboratory for taking point samples in the larger streams.

Studies will be made of the accumulation of flood flows from small areas, and of the assembly and propagation of flood flows through the larger stream channels, to determine the flow and stage reached as the flood progresses downstream. This is a matter on which factual data are extremely inadequate. The rational solution of the land-use phase of flood problems depends on a thorough knowledge of the hydrology and hydraulics of flood phenomena from rivulets to major streams. Not until the accumulative effects of land use on small areas can be traced through to major flood flows will it be possible to determine quantitatively the influence of various types of land use on flood flows.

In order to extrapolate from the maximum area of 5,000 acres available on the Coshocton project, to areas of greater size within the Muskingum Conservancy District or elsewhere, and to evaluate soil and topographic variations occurring in the North Appalachian area, it is necessary that subwatersheds be developed outside the Coshocton area. A gaging station has already been established on Mill Creek, below its junction with Little Mill Creek (the main stream of the Coshocton watershed) giving an area of about 17,600 acres. This station is operated cooperatively by the Muskingum Conservancy District, the United States Geological Survey, and the Soil Conservation Service. Another area of about 53,000 acres on Salt Creek near Zanesville, Ohio, has been gaged for some time by the Soil Conservation Service. This area gives an extrapolation point above that of the Mill Creek station. Other suitable watersheds will be located within the Muskingum Conservancy District and studies made to secure information of peak flood flows on still larger watersheds.

The possibility of a much wider geographical extension of the results obtained will be investigated through run-off measurements on small plots, using artificial applications of rainfall. This will make possible the immediate collection of data by eliminating the necessity of awaiting the occurrence of the range of rainfall conditions during natural storms. It is anticipated that the relation between the run-off from small plots and that from watershed areas can be reliably established, thus enabling extrapolation of the watershed results throughout the North Appalachian region represented by the study. It is believed that a network of these studies, representing the major hydrologic divisions of the United States, will make possible the determination of the run-off and flood-producing characteristics of watersheds in any region where, in the interests of soil and water conservation and flood control, such information may be desired.

Aerial view of the great Elephant Butte Dam. (Courtesy Reclamation Bureau.) Inset: Silt deposits in Lake Meade near Pierce's Ferry; 12 feet thick, 300 feet wide, 1½ years after completion of the reservoir.

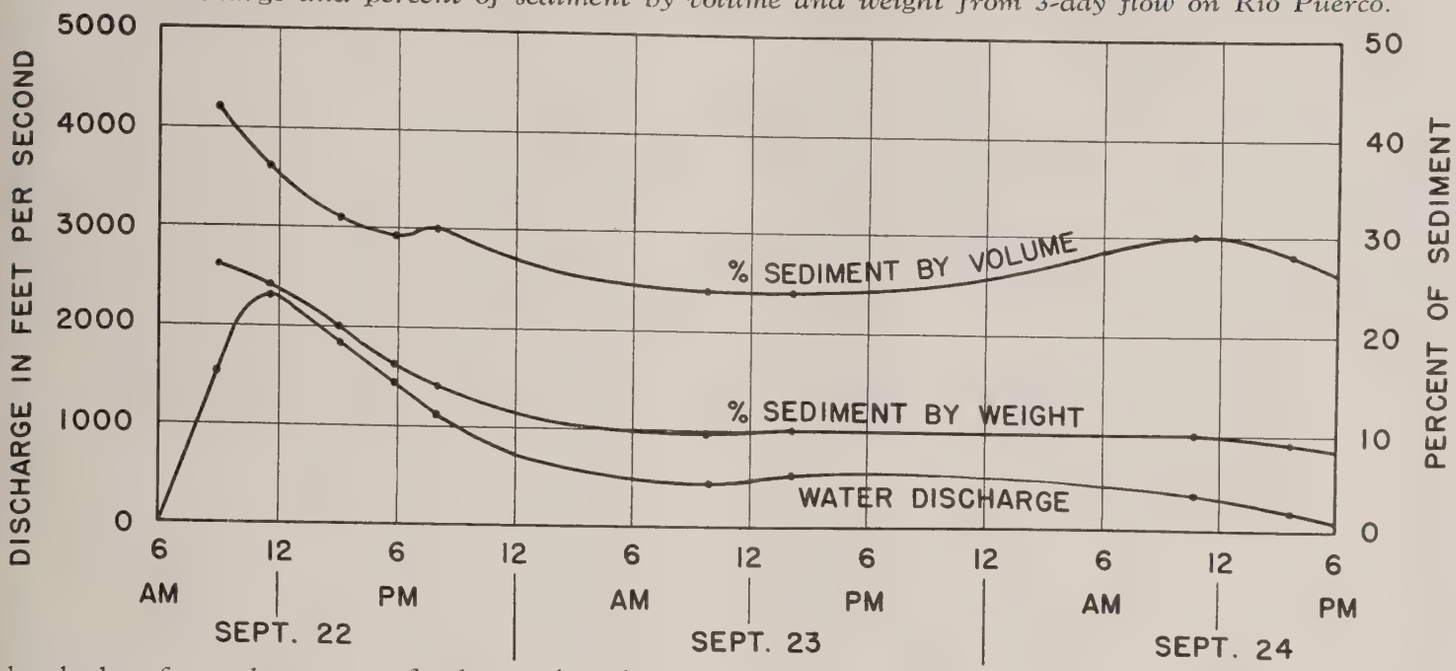
SEDIMENTATION—Continued from page 219

years, 24 percent a life of 50 to 100 years, 21 percent a life of 100 to 200 years, and only 17 percent a life of more than 200 years. Such a situation makes it obvious that a major aim of any watershed conservation program should be the preservation of the effectiveness of these reservoirs and extension of their useful life.

At least one-fifth of all reservoirs in this country, representing probably three-quarters of the total investment, depend solely upon storage for their usefulness. These storage reservoirs, in addition to their various primary functions, exercise an important effect on flood control in the country as a whole; in some watersheds they are a major influence. Flood control through reservoir storage is of prime importance in the Miami and Muskingum watersheds of Ohio, the Trinity and Brazos watersheds of Texas, and is of significance in such watersheds as the Pee Dee and Catawba in the Carolinas where chains of power reservoirs create large storage.

Under the new Nation-wide flood-control program now being developed, the Department of Agriculture is designated as the responsible Federal agency to promote and establish watershed protection designed to supplement downstream flood-control measures developed by the War Department. In this program it seems only natural that one major aim should be the protection of specific downstream flood-control works—reservoirs, leveed areas, channel improvements—against damage by silting. This objective might constitute the keystone of a program which would be distinct from, but parallel with, and using mostly the same practices as, the present program of land treatment designed primarily to preserve agricultural values. In such a program the warranted costs of land treatment might be determined basically

Water discharge and percent of sediment by volume and weight from 3-day flow on Rio Puerco.



by the benefits to downstream flood-control works, or to reduction of flood flows where costly downstream engineering works are not economically justified as in many smaller agricultural valleys. Added to these basic costs, however, would be additional costs justified by benefits to the treated land.

In determining basic costs, this would put the emphasis on downstream or "public" benefits in contrast with the present programs in which they are based largely on private benefits. Land treatment for flood control would be carried out only above downstream flood-control improvements, or above areas subject to appreciable flood damage where engineering works are not feasible. Following such a policy much land might be adequately treated because of downstream benefits which would not justify proper treatment solely from the practical economic standpoint of present agricultural values. This program might run concurrently with, but separate from, the present program based on demonstration areas and conservancy districts located largely to meet agricultural needs and without regard to specific flood-control projects.

It is obvious that an accurate record of damages by silting to existing downstream developments, which affect floods and flood control, is a necessary prerequisite for determining the priority of areas for treatment in any major watershed or for determining the costs of treatment justified in the light of known damages and expected benefits.

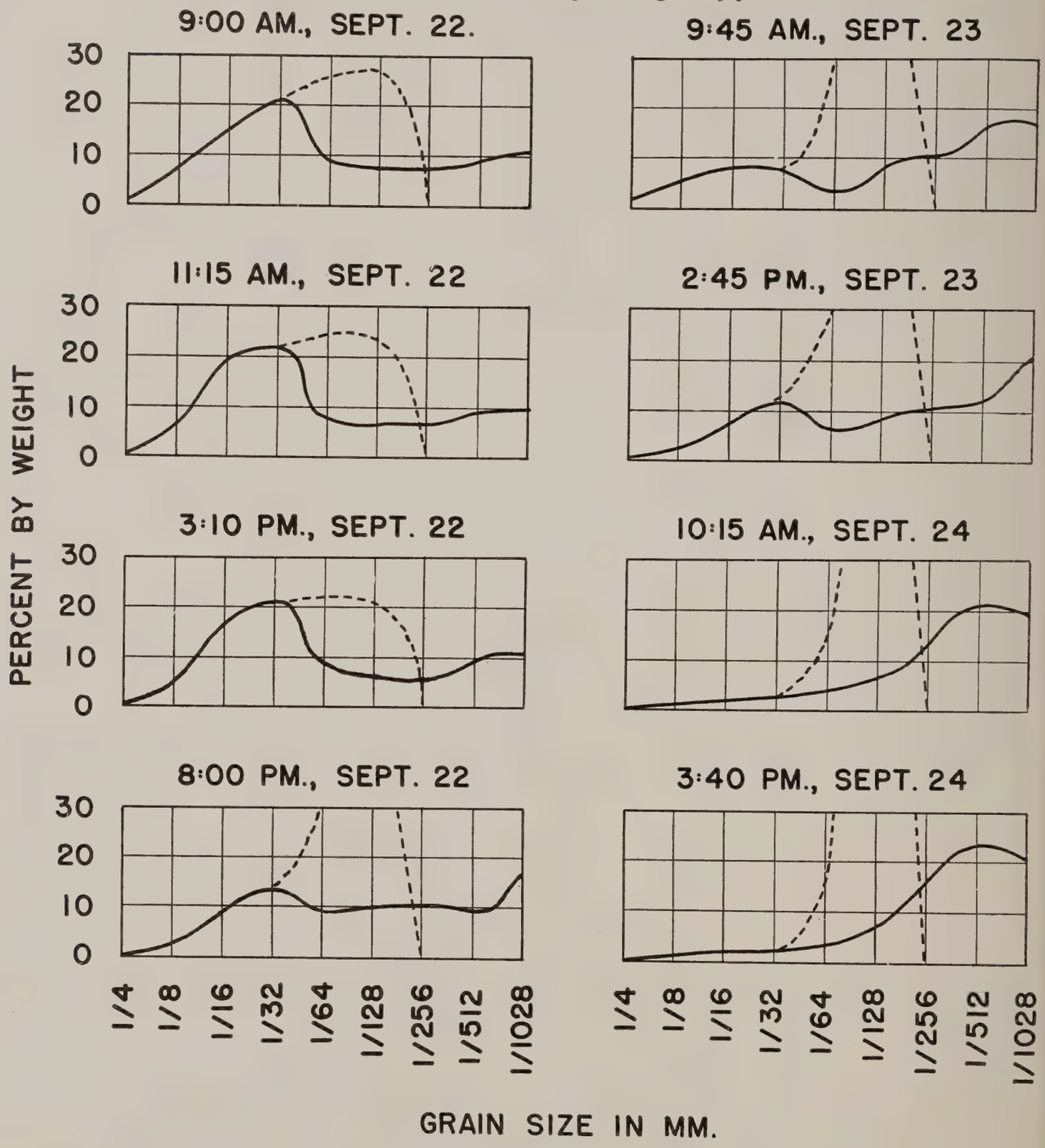
The determination of such damages is one of the principal functions of the Section of Sedimentation Studies. The development of corrective and preventive measures to supplement upland methods of soil conservation is another. For example, corrective measures necessary for full protection of flood-control reservoirs may include stream-bank protection in tributary valleys, storage of erosion debris on waste areas in the alluvial valleys, development of protective vegetative and mechanical treatment around reservoirs to prevent shore-line erosion and screening out and depositing a part of the silt load in the valley just above the reservoir.

Concretely stated, the objectives of sedimentation studies are: (1) To provide accurate information on the damage already done by sedimentation to all downstream resources and developments as well as the magnitude of potential damage to be expected under present conditions and thereby to establish one measure of the relative needs of different watersheds for erosion control and readjustments in land use; (2) to provide more specific knowledge of the natural laws governing the erosion of soil by water; and (3) to develop new and more economical methods of treating and manipulating silt-laden waters to minimize damage to valley agricultural lands and to other developments and resources by control of bank erosion and sedimentation within water courses and on flood plains.

To accomplish these objectives, sedimentation studies are carried on under four separate but interrelated projects which may be described briefly as:

Suspended load samples collected at intervals during 3-day flash flow in Rio Puerco. (Sample on extreme left from Rio Grande above mouth of Rio Puerco.)

Distribution curves of suspended load discharge during 3-day flow on Rio Puerco.



NOTE - DOTTED LINES REPRESENT APPROXIMATE DISTRIBUTION OF SEDIMENT WHEN FLOCCULATED.

(1) Investigations, through field studies and surveys, of reservoir silting as affected by land-use and topographic conditions within the watershed.

(2) Investigations, through field studies, of the sources, quantities, forms, and effects of recent accelerated sedimentation in stream channels and on valley lands, and development of new methods for reducing and eliminating damage by erosion debris through control of bank and channel erosion and

(*Continued on p. 234*)

Economic Implications of a Soil and Water Conservation Program

By Walter J. Roth [1] *and Alexis N. Garin* [2]

SOIL conservation in contrast to soil misuse may be viewed from the standpoint of the farmer or the public. The farmer may reasonably ask, "How far will it pay me to go in adopting and operating a soil conservation program under my conditions of soil and slope, the degree of erosion on my farm, the limitations of the climate in my area, and the specific market opportunities open?" Similarly, the public may ask, "How far should we contribute to a soil and water conservation program on private land in order to avoid the damages from erosion on lands which cannot of themselves pay for soil conservation? What price ought we pay to obtain the widespread social and economic benefits of soil and water conservation?"

Answers to these questions may be suggested by a specific instance of how a soil and water conservation program works when applied to an individual farm and how the absence of such a program affects the public interest. Inferences may be drawn from studies covering the damages to highways from erosion in one of our Northern States and from studies covering the siltation damages to municipal water-supply reservoirs in one of our Southern States.

Individual Farmer Point of View

The individual farmer's point of view on a specific farm is shown in an economic survey of the farms of the Crooked Creek demonstration area in western Pennsylvania. The total watershed comprises 120,000 acres lying in Indiana and Armstrong Counties within the Allegheny Plateau region, where elevations range from 950 to 1,600 feet. The topography is rolling to steep. Soils derived from sandstones and shale prevail. Their virgin productivity never was high and, being shallow, growing crops are adversely affected by dry weather. Much of the cultivated land is on steep slopes. Because of cultivation on these steep slopes, the shallow, sandy, and shale soils lack humus, and under the heavy Appalachian rains erode severely. The crop land has suffered from erosion, as has the pasture and other land, while in contrast, the wooded land shows little erosion. The pasture and other lands are badly eroded, this being former crop land abandoned because of erosion.

The farming may be classed as general in type. Livestock and livestock products account for approximately three-fourths of the gross farm income. Of the livestock enterprises, dairying and poultry are most important.

From the details of the survey covering farm organization, farm operation, farm income, and related items, it is possible to select a farm typical of the full-time farms in the area, and to project its operation into the future for a period of 5 to 10 years under a continuation of its present soil-depleting system. In contrast, and as a basis for judging the feasibility of the soil-conserving system, the same farm may be reorganized according to the recommended soil- and water-conservation programs and its operation likewise projected into the future for 5 or 10 years. A comparison of the results should furnish an opportunity to compare the economic feasibility of the one versus the other. This has been done and is reported here in tabular form.

The details of the changes involved are shown in the table and need not be restated here. It is sufficient to note that the size of farm remains constant throughout the period while the crop acres are reduced in both cases, particularly under the soil-conserving system. The changes in cropping under the soil-depleting system involve some shifts in acreage and notably some decline in yields. This is a normal consequence of soil misuse. In contrast, the soil-conserving system may correctly be expected to produce increased yields. The yields reported are not excessive; in fact they may be considered very conservative in view of the careful land selection, the crop rotations, the application of lime and fertilizer, and the control of erosion. Another feature of the soil-conserving system is the increase in the permanent pasture and woodland acreage. No woodland in the soil-conserving system is mistreated through grazing, a practice which is continued under the soil-depleting system. Idle land, which increases under the soil-depleting system, is restored under the

[1] In charge, Section of Economics of Soil Conservation, Division of Research, Soil Conservation Service, Washington, D. C.
[2] Assistant agricultural economist, Section of Economics of Soil Conservation, Division of Research, Soil Conservation Service, Washington, D. C.

Organization and Financial Statement of a Representative Farm in Western Pennsylvania

	Present			5 to 10 years hence					
	A. The current system			B. The soil depleting system			C. The soil conserving system		
Size of farm ... acres	105			105			105		
Crop land ... do	56			54			50		
Permanent pasture ... do	23			21			28		
Woods pastured ... do	4			4			...		
Woods not pastured ... do	9			9			21		
Farmstead, idle ... do	13			17			6		
	Acres	Yield	Production	Acres	Yield	Production	Acres	Yield	Production
Crop production:									
Corn	8.5	34.0	289	7.5	29.0	217.5	9.0	37	333
Oats	8.5	25.0	212.5	7.0	23.0	161	9.0	28	252
Wheat	6.0	12.0	72	6.0	10.0	60	6.0	15	90
Rye	3.5	10.0	35	3.5	9.0	31.5	2.0	12	24
Buckwheat	2.5	23.0	57.5	3.0	21.0	63	1.0	25	25
Potatoes	1.0	100.0	100	1.0	80.0	80	1.5	120	180
Hay, total	19.0	1.0	19	17.0	.9	15.3	21.5	1.3	27.75
Alfalfa	.5	2.0	1	...	...	...	1.5	2.5	3.75
Mixed	14.0	1.0	14	14.0	.9	12.6	16.0	1.2	19.2
Other	4.5	1.0	4.5	3.0	.9	2.7	4.0	1.2	4.8
Pasture	7.0	...	...	9.0	...	...	...	...	...
Receipts, annual:									
Livestock			$884.00			$738.00			$1,184.00
Crops			97.00			77.00			180.00
Miscellaneous			15.00			15.00			15.00
Total			996.00			830.00			1,379.00
Expenses, annual:									
Fixed charges			421.00			421.00			421.00
Variable expenses			538.00			485.00			721.00
Total			959.00			906.00			1,142.00
Farm income			37.00			−76.00			237.00

opposite system to some use, as woodland or pasture or possibly crops. An improvement in the quality of the pasture and in crop yields is expected.

The net effect of these changes is indicated by receipts, expenses, and farm income under the three systems.

The continued operation of a soil-depleting system is followed by a decline in farm income. Despite a decline in expenses also, the farm income falls below the previous income used as a base. Apparently the soil-depleting system cannot maintain the farm as an income producer. In fact the estimated receipts are actually lower than the amount necessary for estimated expenses, resulting in a negative farm income. In the soil-conserving system, despite a higher total for annual expenses, the earning is higher than the original farm income, and considerably higher than the returns from the soil-depleting system.

No particular changes in labor, power, or equipment are contemplated in the soil-conserving system. In spite of expansion in some crops, the smaller total crop area will not require additional operations expenses. The additional outlays, termed variable expenses, are intended to cover seed, lime, fertilizer, and harvesting charges. Some added livestock costs are also involved, since concentrates are purchased to supplement the additional hay. The extra potatoes are sold and feed grains and hay are fed to the dairy cows and poultry, these two lines of animal husbandry having an available market.

As to the estimate covering maintenance of erosion-control structures and other soil-conservation measures, this figure is low, the assumption being that the only measures necessary are the changed cropping program, some strip cropping, contour operations, and a few inexpensive structures. The latter are built of local materials with local labor and require no large annual cash outlay. The changed cropping includes some change to pasture, some shift to woodland, and the protection of woodland from grazing.

Public Point of View

Under the public aspects of soil conservation are included (1) the effects of public policy affecting soil conservation, i. e., public land policy, credit institutions, land tenure, taxation, research and education, benefit payments, legal phases; and (2) those phases of erosion control which invade more than one land unit and cause direct damage to other individuals and the public.

In a general way nearly everyone now recognizes that soil erosion is a destructive force which touches

the public purse in many ways. If the type of knowledge that is most useful to public commissions in charge of public enterprises affected by erosion, to legislators, and to government officials is to prevail, the indefinite general impressions concerning damages and the costs of correction must be replaced as rapidly as possible by more definite measurements. In this connection brief analyses of cost studies are here presented.

A reconnaissance survey of erosion damages to highways in 16 southwestern counties of Wisconsin, comprising about one-fifth of the State, shows that for each mile of public highway (total of 20,596 miles) at least $42 is spent yearly to repair erosion damages to banks, shoulders, road beds, drainage ditches, bridges, and culverts. Although the data secured during this survey are in many respects inadequate to make a satisfactory appraisal of the total damage caused by erosion and of the methods that are economically desirable to reduce the damage, enough information was secured to indicate that prevention of the more serious damages, at least, is less expensive than their repair.

The preliminary results of investigations of public expenditures for municipal water-supply reservoirs and appurtenent developments in North Carolina, made in cooperation with the Research Section of Sedimentation Studies, shows that for Burlington, Greensboro, High Point, and Winston-Salem, the initial investment amounts to a total of $2,655,000 for the present aggregate water-supply sources of these cities. To this original investment must be added interest on bonds. As these cities have financed their water-supply development by issuing 30- to 40-year serial bonds, it can readily be seen that at the end of 40 years when the last bonds will be paid for, assuming that equal amounts are retired each year during the period, the original investment will be approximately doubled at 5 percent interest. This will bring the total investment up to $5,310,000 at the end of 40 years.

The rate of silting of the Greensboro and High Point reservoirs was investigated in 1934 by the Section of Sedimentation Studies and later an estimate was made on the basis of a reconnaissance survey of the rate of filling of the Burlington and Winston-Salem reservoirs. The average rate of silting of the four reservoirs will amount to a loss of 36 percent of the original capacity at the end of 40 years. The annual monetary loss of this depletion is around $48,000, or a total of approximately $2,000,000 at the end of 40 years, using the original investment plus interest as the amount of actual outlay.

The total drainage area of this group of reservoirs is approximately 178,000 acres. According to information on actual sales, opinions of local real-estate dealers, and land-bank appraisers, the average value of an acre would not exceed $40. This gives the total land value of the four watersheds as approximately $7,120,000. Startling as it may seem, the municipal water-supply developments represent an investment of approximately three-fourths of the total land value in the drainage basins in question. In the case of one of the cities, its reservoir cost alone is considerably more than the total land value of its entire watershed.

Because we have no accurate physical data upon which to base an estimate of the probable effectiveness of our soil-erosion control measures in reducing the relative proportion of silt loss to flood run-off, the more exact calculations of this public aspect of soil conservation are somewhat limited. There are, however, in the Deep River area of High Point two first-class stream gaging stations maintained by the United States Geological Survey, and a considerable number of discharge measurements have been made since the Soil Conservation Demonstration Project was established there in 1934. Silt sampling has been carried on since that time during all periods when the amount of suspended matter was appreciable. The results show a 25-percent decrease in the quantity of suspended matter in stream discharge since 1934. This decrease is constant whether based on monthly and yearly averages or on individual storms of approximately the same intensity and duration. The period is too short, however, to reach final conclusions. It should also be borne in mind that only about 45 percent of the land in the watershed is covered by cooperative agreement with the Service.

The cities thus far contacted have expressed a willingness to spend substantial sums for erosion control, provided the entire watersheds are brought under control to ensure certain and tangible protection. With this in view the Service is contemplating a complete cost study of the erosion-control measures applied on the Deep River watershed at High Point and the Horsepen Creek drainage area at Greensboro. It is hoped that we shall then be in a position to answer inquiries from cities concerned with impairment of investments due to silting of reservoirs and the costs of clarification of silty waters for municipal use. Further, as a major objective, the Service expects to work out an adequate factual basis for effective cooperation in controlling erosion in tributary watershed areas, including public highways which contribute to the aggregate erosion problem.

Recent Achievements of the Section of Climatic and Physiographic Research

By C. W. Thornthwaite [1]

Above: Mass movement of the soil beneath the vegetal cover is an important process in shaping the slopes of humid lands. The flowage and slumping on this Ohio hillside involved about one-half acre of land and occurred after heavy rains.

Left: In limestone lands having subsurface drainage erosion exhibits peculiar features such as the circular scars in this aerial view in Meade County, Ky. Such areas demand special methods to control erosion.

IN THE April 1937 issue of SOIL CONSERVATION the research program of the Section of Climatic and Physiographic Research was outlined briefly.[2] At that time it was pointed out that the work of the section was limited to observational and library studies, phases of research rarely encountered in the Department of Agriculture, but which are of especial value in amplifying and supplementing controlled experimentation by providing an historical perspective and supplying means for extrapolating the results of experimentation beyond the limits of the area in which the experiments are conducted.

The objectives of the Erosion History Unit are to assemble the results of past experience of practical farmers in controlling erosion, to determine the types of land-use practices which were responsible for the incidence and spread of erosion, and to collect information on the development of erosion-control practices in foreign countries having climates and erosion problems similar to our own.

Since erosion is a geologic process, it is the function of the Physiographic Unit to determine the influence of rock type, structure, and the slope and exposure of the land, on the forms of erosion which develop and the physiographic processes involved.

Since these processes vary with climatic conditions, the Climatic Unit has undertaken the work of delimiting climatic regions within which erosion and erosion-control practices would be similar, determining the effect of various types of rainstorms on erosion through the life history analyses of storms, developing improved methods of determining the expected frequency of rains of high intensity, and contributing to our knowledge of the relation of rainfall to run-off and the influence of land-use practices on run-off. The Ecology Unit has as its objective the determination of the relationships between plant succession and erosion control and stabilization.

During the interval since the summary statement of the research program was published, considerable progress has been made along several lines.

Climatic Research

The climatic research station established in western Oklahoma in 1935 continued in operation until July 1, 1937, when it was discontinued because of insuffi-

[1] Head, Section of Climatic and Physiographic Research, Division of Research, Soil Conservation Service, Washington, D. C.

[2] C. W. Thornthwaite: The Research program of the section of climatic and physiographic research, SOIL CONSERVATION 2:218–220, 236. 1937.

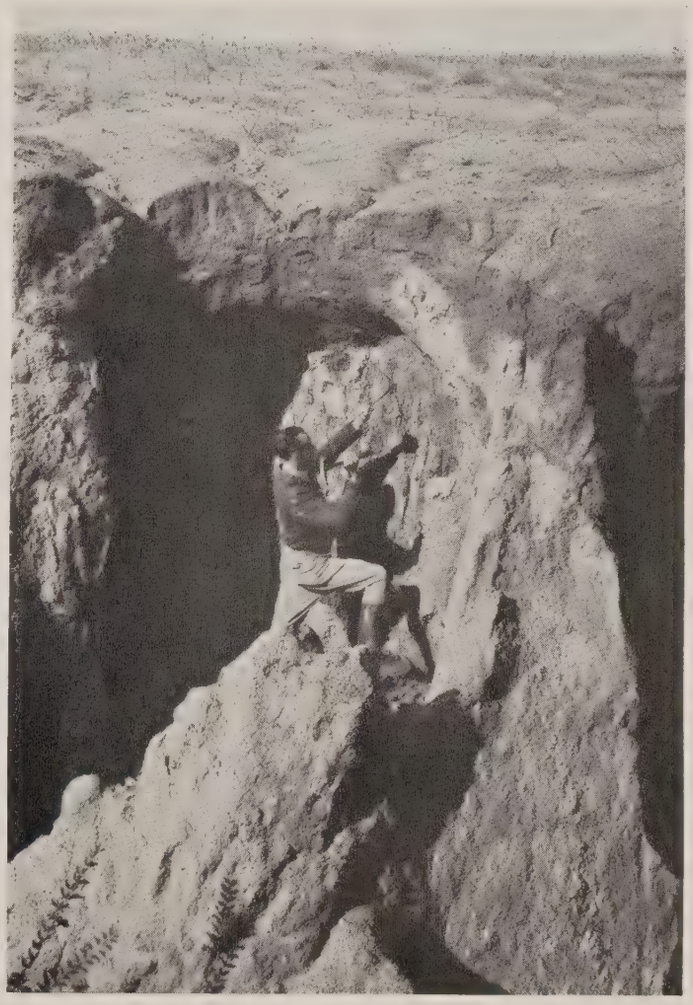
cient funds. During the year-and-a-half of operation a large amount of information on the history of rainstorms was collected. This paved the way for the establishment of a similar but considerably larger climatic research station in Ohio as a State W. P. A. project, with the Muskingum Watershed Conservancy District cooperating. In this project, covering 8,000 square miles of the Muskingum Valley, 500 self-recording rain gages and an equal number of instruments for measuring temperature, relative humidity, and wind velocity and direction were installed at intervals of approximately 4 miles. The construction stage of this project commenced in April, and reliable data were being obtained by the 1st of June. Maps showing the distribution of surface temperature for each hour of the day were made commencing with that date. Precipitation maps showing the distribution and intensity of rain for half-hour intervals were made for the period beginning July 1. For a continuously rainy day, 48 of these maps must be made. It required 667 maps to represent the rainfall for the month of July, and 2,258 maps for the period from July 1 to November 1. As in the Oklahoma research project, maps are made for temperature, relative humidity, wind velocity and direction, and cloudiness for each hour.[3]

During the period of operation of the Oklahoma climatic research station, and the period of construction in the Ohio station, noteworthy progress has been made in the development of improved inexpensive instruments. A self-recording rain gage, which has proved adequate in all respects, was developed and has been manufactured at a price only approximately 25 percent of the previous price. Nearly 2,000 of these automatic rain gages have been put into service in the United States during 1937. Similarly, a new anemometer and wind vane were designed and manufactured at only a fraction of the cost of any satisfactory previous instrument. Similar economies were effected in the design of instrument shelters and wind towers. An accessory to the recording rain gage, which gives on the rain gage chart a continuous record of wind velocity and direction as well as precipitation, has been developed. The complete assembly for giving a continuous automatic record of precipitation and wind velocity and direction can be obtained for approximately one hundred dollars when purchased in quantities. An evaporation pan giving a continuous record of evaporation is the most recent development at the Ohio project, where a sample instrument is now on test.

[3] Leonard B. Corwin: Sampling the weather at the Oklahoma climatic research center. Soil Conservation 2: 237–238, 244, illus. 1937.

The material obtained at the Oklahoma and Ohio centers has proved indispensable in the study of rainstorm morphology. It makes possible the determination of the frequency of rainfall of specified intensities and amounts at individual stations and also of storms of specified size and duration over entire watersheds. This information also aids in determining the meteorological conditions which produce rains. It is hoped that it may be possible through this study to determine the combination of meteorological conditions which would produce the maximum storm and thus to determine the size and extent of this limiting storm.

The climatic data being recorded on the Muskingum in Ohio are especially significant because of the stream-gage measurements being made on a large number of the intermediate and smaller tributaries by the United States Geological Survey and the Muskingum Watershed Conservancy District, and because of the location of the Land-Use Hydrology Watershed project of the section of Watershed and Hydrologic Studies of the Division of Research. The unparalleled rainfall record



Detailed studies were made of representative examples of the deep caving gullies of the southern Piedmont. Measurements of erosion were made from iron rods driven deep into the gully heads and walls.

being obtained through the operation of the close network of self-recording rain gages and the determination of run-off from the several watersheds of the valley has permitted the study of the relation between rainfall and run-off on an entirely new basis. It is believed that this study of rainfall-run-off relations will make possible the determination of the effect of land use on floods. The climatic information being obtained makes it possible to treat each rainstorm as an individual event, and permits the isolation of the various influences which produce variations in the rainfall-run-off relationships.

A recent bulletin, "Sources of Moisture for Precipitation in the United States",[4] by Benjamin Holzman of the staff of the Climatic and Physiographic Research Section, forms an important contribution to the literature of climatology. In it the author demonstrates the intimate relation between modern air-mass meteorology and hydrology. He presents a revised concept of the hydrologic cycle. Implications of this study have been presented in a previous article [5] in this magazine.

Of immediate practical value is research on precipitation intensity frequency conducted by Katharine Clarke-Hafstad. It is recognized that engineers in designing erosion and flood-control structures require a measure of the frequency of rains of specified intensity and amount. The two most valuable methods for determining rainfall intensity frequency are the so-called station-year method, employed by the engineering staff of the Miami Conservancy District,[6] and the Yarnell [7] method. It has been pointed out previously that both methods yield inadequate results.[8] The present spacing of stations makes it impossible to record all the intense storms that cover small areas, and causes the too-frequent sampling of storms of lower intensity that cover large areas. The station-year method combines records of various lengths from several stations to obtain an aggregate station-year record. This aggregate record has been assumed to represent a long period record for a single station. Because of the too-frequent sampling of storms of lower intensities it has been shown that only a part of the aggregate station-year record can be said to be valid.

The method employed for testing the amount of duplication in the rainfall records is based on a statistical technique used in testing persistence in observations taken at equal time intervals. It is possible by this technique to determine which combination of stations and years yields the most information on the frequency and intensity of rainstorms.

In determining rainfall intensity frequency Yarnell employed only the records from the automatic rain gages at the 211 first-order Weather Bureau stations scattered over the entire United States. The analysis of the voluminous rainfall records from the 500 gages in operation in the Muskingum Valley, now in progress, should give some idea of the size and number of storms missed in the Weather Bureau station network, which will in turn permit a revision of Yarnell's values for storms of short duration and high intensity.

Physiographic Research

General unfamiliarity of agricultural research workers with geological processes affecting land forms calls for special consideration. On this account, the first publication of the unit, "What is Soil Erosion?" [9] examines erosion from the standpoint of the geologist or physiographer, and attempts to show the relation of what is popularly called "geological erosion" to soil erosion. With the aid of many illustrations it describes the various physiographic processes involved in soil wastage, indicates in nontechnical language some of the regional variations in these processes, and the climatic and geologic basis for such variations.

In order to stress the relation of physiography to soil erosion the first research projects were designed to study a variety of physiographic processes in widely contrasting regions. A manuscript on soil erosion in the limestone lands, submitted for publication by Samuel N. Dicken and H. Bates Brown, Jr.,[10] in September 1937, deals with the peculiarities of soil erosion in regions where the drainage is subterranean. In the United States there are more than 5,000,000 acres of agricultural land in which channels have been dissolved in the soluble limestone, and on which surface drainage is partially or entirely lacking. As a result of the absence of surface drainage, soil erosion exhibits peculiar characteristics, and methods of erosion control successful elsewhere cannot be applied.

A second technical study, dealing with principles of gully formation in the Piedmont, by H. A. Ireland, C. F. S. Sharpe, and D. Hoye Eargle [11] was submitted for publication in December. Because of the deep

[4] Benjamin Holzman: Sources of moisture for precipitation in the United States. U. S. Department of Agriculture, Tech. Bull. No. 589, 41 pp., illus. (October 1937).

[5] C. W. Thornthwaite: The hydrologic cycle re-examined. p. 85, October 1937, Soil Conservation.

[6] Engineering Staff, Miami Conservancy District: Storm rainfall of Eastern United States (revised). Technical Reports, pt. V. 352 pp., illus., 1936.

[7] David L. Yarnell: Rainfall intensity-frequency data. U. S. Department of Agriculture Misc. Pub. No. 204, 67 pp., August 1935.

[8] C. W. Thornthwaite: The reliability of rainfall intensity-frequency determinations. Trans. Amer. Geophys. Union, pp. 476–488, illus. 1937.

[9] C. F. S. Sharpe: What is soil erosion? U. S. Department of Agriculture Misc. Pub. No. 286. (In press.)

[10] Samuel N. Dicken and H. Bates Brown, Jr.: Soil erosion in the limestone lands of western Kentucky. (In manuscript.)

[11] H. A. Ireland, C. F. S. Sharpe, and D. Hoye Eargle: Principles of gully erosion in the Piedmont of South Carolina. (In manuscript.)

weathering of the bedrock in the southern Piedmont, gullies cut rapidly to great size and present a difficult problem in erosion control. Field studies demonstrate the relation of the deep, caving gullies to specific rock and soil types and land-use practices. Detailed observations on representative gullies show the processes by which they are formed, and the close correlation of these processes to climate and vegetation. Caving of the gully head and walls, and clearing out of the channel, the principal elements in the process of gully formation, are found to be dependent on rainstorm types, and the annual cycle in these processes is controlled by seasonal changes in the climatic forces. In knowledge of the areas of inherent vulnerability, of the processes active, and of seasons of special hazard we are close to the root of the gully-erosion problem. These are the basic data on which erosion-control techniques particularly adapted to the Piedmont must be planned.

Recent field studies have suggested that the natural erosion in humid lands was not only less in amount but was also of different type from the present culturally-induced erosion. It is apparent that under natural conditions where the soil surface was almost completely covered with vegetation and with the organic products of plant life, gullying was practically nonexistent and sheet wash was so slow as not to interfere with soil-forming processes. Thus, there is the suspicion that most of the denudation was due to mass movement—slow, downhill soil creep, earth flow, and slumping. The evidence of this form of denudation is usually less conspicuous than the evidence of gullying and sheet wash. For this reason there is a tendency to minimize its relative importance. Field studies of mass movement to identify its various forms, and to determine their significance and areal distribution, are under way.

Erosion History

At the beginning of 1937 a bulletin entitled "Early Erosion-Control Practices in Virginia," by A. R. Hall,[12] was published by the Department. Virginia was one of the earliest agricultural areas in the United States and Hall's purpose was to indicate the importance of soil erosion in the area from the beginning of settlement. A second manuscript, "Erosion and Its Control in Oklahoma Territory", by Angus McDonald,[13] is now in press. Oklahoma Territory was the last large agricultural area to be occupied, and in this manuscript McDonald shows how much damage was done to the land in the short span of 20 years, and describes the methods which farmers developed in attempting to prevent or control soil erosion.

Erosion history research projects are now in operation in seven States. Each project consists of one trained supervisor and 20 or more relief workers. On the basis of early experience, a uniform system has been developed for examining early records and transcribing verbatim those items dealing with erosion and floods, control measures employed, and the related land-use practices. The information secured will serve as source material for future publications.

An aspect of erosion history research which should give perspective to our present erosion-control activity is the study of the history of erosion and its control in the ancient world and in foreign countries in our own day. These fields of research are now in progress under the direction of Lois Olson and it is expected that within the coming year two papers will be forthcoming—one dealing with erosion in the ancient world and the other with the contemporary experiences in foreign countries. The straight furrow, so prized by our present day American farmers, has been traced to Cyrus of Persia, in the fifth century, B. C., and contour cultivation now being advocated was described by Pliny the Elder in the first century, A. D. Dry land farming is found to have been a common practice among the Romans.

Ecologic Research

Despite the recognized importance of vegetative cover in erosion control and the urgent need for the determination of principles of plant succession on eroded areas, a comprehensive program of ecologic research, although formulated, awaits further development. A certain amount of work incidental to research discussed above has been done, but it is not focused on the problems involved in the use of vegetation in erosion control.

As has been pointed out previously, the various lines of investigation in the section of Climatic and Physiographic Research must be conducted as a single integrated unit. Each advance in one line aids in interpretation and stimulates further advance along another line. For example, rainstorm analysis suggests a new approach to the study of physiographic processes of erosion and supplies a new interpretation of erosion processes and forms. The history of erosion supplies a basis for evaluating the effect of erosion on the magnitude of floods.

[12] A. R. Hall: Early erosion-control practices in Virginia. U. S. Department of Agriculture Misc. Pub. No. 256, 31 pp., illus., 1937.

[13] Angus H. McDonald: Erosion and its control in Oklahoma Territory. U. S. Department of Agriculture Misc. Pub. No. 301. (In press.)

The Soil-Saving Persimmon

By S. B. Detwiler [1]

A persimmon tree in North Carolina. (Courtesy Forest Service.)

THE NATIVE persimmon is one of those long-neglected wild plants offering outstanding promise for profitable development under hillculture principles. It is likewise an erosion-control plant of the multiple-use type urgently needed in developing practicable methods for sound and permanent agricultural use of sloping lands.

The area in which the common persimmon is native or will thrive when planted lies south and east of a line from Boston to Columbus, Des Moines, and San Antonio. This territory of approximately 900,000 square miles contains more severely eroded hilly farm land than any other portion of the United States. Excluding the higher elevations and other areas not adapted to this species, it is safe to estimate that the persimmon is today naturally distributed over an area of not less than 500,000 square miles.

The function of hillculture research is to secure cooperative action in finding and improving erosion-resisting plants having superior economic qualities for general use in soil defense. One phase of this work relates to the methodology of land organization and the application of ecological principles in managing perennial plant covers for the safe use of steep lands in producing profitable crops furnishing annual returns to the farmer. The persimmon has high intrinsic value for these purposes.

Recent discovery of a new and deadly wilt-disease, which may destroy the future usefulness of the persimmon if it is not checked, is news of major importance to all soil conservationists. This disease was first found in 1937, and the oldest known infections date back only 7 years (possibly only 4 years). It is caused by an undetermined species of *Cephalosporium* and has infected trees in approximately half of the persimmon stands growing in an area of some 1,500 square miles lying southeast of Nashville, Tenn. Hence, it is timely to evaluate the merits of this tree. What, then, is the actual value of the persimmon on the 500,000 square miles of its distribution today, and what might it become if preserved and improved for soil-saving farming purposes? The answer is best given by quoting what some leading authorities on this subject have to say about the importance of the tree.

Dr. H. H. Bennett has long and closely studied soil-erosion conditions throughout the region of the persimmon. He is a keen observer of erosion-control vegetation and is preeminently qualified to speak on persimmon in relation to erosion control. Under date of December 17, 1937, in a memorandum to the writer, Dr. Bennett states the case forcefully. He writes:

> Since I talked with you a few days ago about the recently discovered persimmon disease, I have been thinking further along the line of the value of the persimmon tree in connection with our national combat against erosion.
>
> My observations have been that persimmon is one of the first plants to take hold of abandoned eroded areas over an enormous area lying roughly south of the Potomac and Ohio Rivers and the northern part of the Ozarks. Not only has this plant come in voluntarily over many thousands of acres of land thrown out of cultivation because of excessive erosion, but it comes in, in many instances, in thick growth such as causes the development of a layer of leaf litter which has considerable effectiveness in slowing down erosion. In many of these areas erosion has been completely arrested through the voluntary activities of this tree. I have further noted that the roots are long and are difficult to kill. In south-central North Carolina, my experience in cultivating the land where persimmons have previously taken hold has been that sprouts continue to come back almost regardless of the breaking up of the roots with plowing and hoeing of cotton and corn. Accordingly, it seems to me that the root system of the persimmon adds to the effectiveness of this plant in holding soil against erosion.
>
> Because of the high carbohydrate content of the persimmon and the readiness with which it is eaten by livestock, I have thought

[1] Head, Section of Hill Culture Research, Division of Research, Soil Conservation Service, Washington, D. C.

since the beginning of our hillculture studies that this tree should be given a great deal of attention in connection with our plantings on the 18 or 20 percent of land now cultivated which should be retired from cultivation to permanent protective cover of grass, trees, and shrubs. We have a great many varieties or strains of persimmon, which I believe you should consider in a very serious way in your hillculture tests.

This disease threat that you told me about concerns me a great deal. If there is any contribution that this organization can make in any cooperative way to combat the disease in its infancy, it seems to me it is our duty to let those of the Department who are primarily concerned know that we stand ready to help. I wish you would bring these matters to the attention of those of the Department who may be most interested in the matter.

Brief discussion of the Japanese persimmon is in order because it illustrates the economic value of persimmons in general and also because the new disease, if not checked, may attack the introduced species. Knowles A. Ryerson, in California Station Bulletin No. 416 on Culture of the Oriental Persimmon in California, says:

Until recently the persimmon has been grown primarily as a side line, but from present indications in the near future its culture will be an important industry in certain parts of California.

The persimmon has long been the most widely used staple fruit of the Orient. Both fresh and dried, it fills an important place in the diet of China and Japan and has been referred to as "the apple of the Orient" as indicative of its importance there.

The area in the Southern States which can be devoted to persimmon growing is large, and as the public becomes increasingly familiar with the uses of the fruit, it is reasonable to expect that there may again be a marked increase in acreage in that region.

John W. Hershey, tree crop specialist of the T.V. A., in Tree Crops and Their Part in the Tennessee Valley, says of the persimmon:

This fruit shows evidence of being one of the leading "tree crops" of the future. Unlike our orchard fruits, it has few pests, is high in food value and has a good flavor. When dried it tastes somewhat like the fig, but is more easily digested. It grows everywhere and anywhere, even on the poorest soils in the Valley whether or not the farmer desires it. Pigs, sheep, hogs, cattle and wildlife thrive well on this fruit.

The importance of persimmon in development of hill-culture farming is most effectively summarized by Dr. J. Russell Smith, of Columbia University, in his vitally important, very practical, and easy to read book, Tree Crops. Dr. Smith has devoted 40 years of intensive study to evaluation and demonstration of the possibilities of tree crops. In explaining the purpose of his book, Dr. Smith says:

This book is primarily an attack upon the gully. To succeed in this we must have millions of acres of tree crops replacing the destructive plow crops . . . Once we get a cow-feed tree crop established we have a guaranteed outlet, and 20 or 30 millions of acres will not glut the market.

The use of persimmon wood is stated as follows in U. S. D. A. Bulletin No. 1436, Utilization of Dogwood and Persimmon:

The woods of flowering or eastern dogwood (*Cornus florida*) and persimmon (*Diospyros virginiana*) are important in American industry not because of the quantity consumed but because of the unusual combination of properties which fits them for special uses. Other woods have some of the same properties, such as hardness, toughness, fineness of texture, and smoothness when subjected to wear, but few if any possess them all to such a degree as dogwood and persimmon. This combination of properties is of special value for shuttles, bobbins, spool heads, golf club heads, infants' shoe lasts, small handles, brush backs, turnpins, mallets, pulleys, and many novelties.

Of the 8,000 cords of persimmon consumed for dimension stock in 1923, 6,650 cords, or 83 percent, was used in the manufacture of 2,600,000 shuttle blocks, and 17 percent, or 1,350 cords, for golf club heads and shoe lasts.

For people who think in terms of dollars and cents, we may venture to estimate the present cash value of the native persimmon in the United States. Assuming that the forage value of this carbohydrate-rich fruit for farm livestock and wildlife is worth several times the value of the fruit for human consumption, and that the industrial value of the wood and fruit are of present minor importance, but that the soil-conserving benefits of persimmon roots and litter are of high value, it seems reasonable to believe that the present growth of the persimmon is worth at least 5 cents per acre annually on the average acre throughout the half million square miles where it is now well distributed. On this basis, the persimmon returns $16,000,000 in value each year to the people of the United States. If this figure is capitalized at 4 percent the persimmon represents a present capital of $400,000,000. These figures can only be a guess, but the facts and views presented herewith indicate them to be conservative. The rational basis for justifying a strong effort to save the persimmon should be based on the need for superior selections of this tree and similar economic erosion control species in developing a permanent agriculture. The history of epidemic plant diseases makes it clear that they are a continual potential threat against all of our beneficial plant life, without which man cannot live.

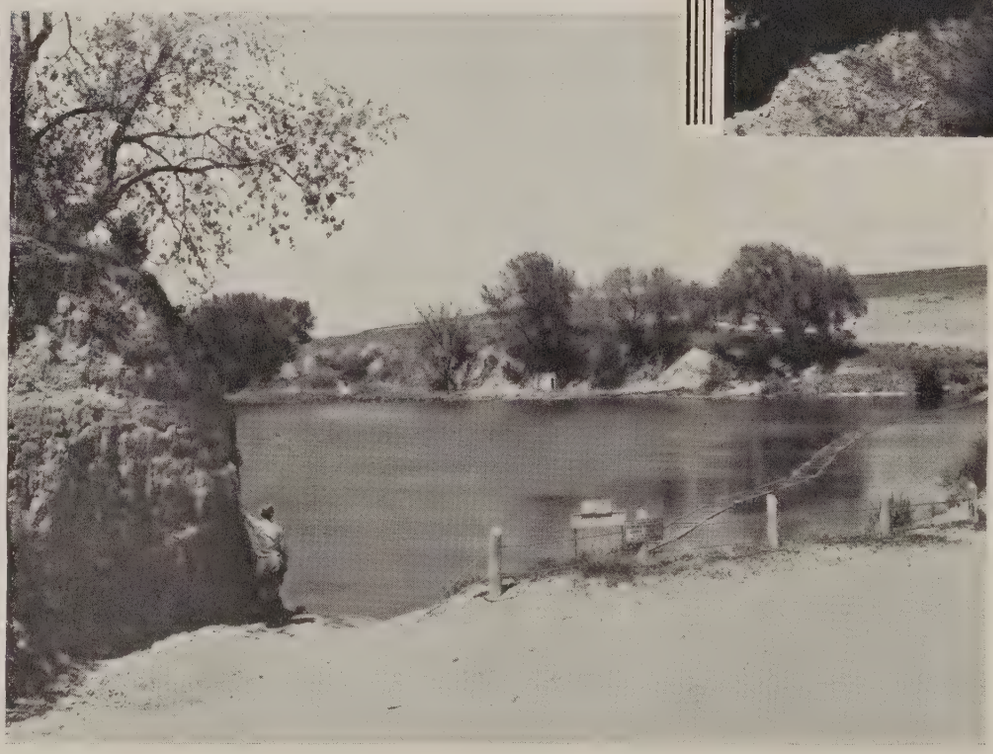
Diospyros virginiana; fruit, yellow-orange. A specimen from Louisiana.

Preliminary Notes on Reservoir Studies in the Great Plains States

By Mark P. Connaughton [1]

DURING the past summer, the Section of Sedimentation Studies of the Division of Research completed 10 reservoir sedimentation surveys in the Northern Great Plains States. For the convenience of the reader, a partial summary of data collected in the studies based on these surveys is here shown in tabular form. The surveys were undertaken primarily to measure rates of sedimentation and to establish a means for future correlation of soil losses and rates of run-off from representative watersheds with factors of climate, soils, slopes, and land use. Detailed conservation surveys of the various watersheds will be necessary before the main factors involved in sedimentation can be isolated and their relative importance correctly determined. However, a general analysis based on reconnaissance will be given in the advance reports of the 10 individual studies which are now in preparation.

Enormous gully head developed in loess in the watershed of Wellfleet Lake, Lincoln County, Nebr.



Eroding banks of loess. This lake has lost 10.6 percent of its capacity in 5 years and 7 months because of silting due to soil erosion in its watershed.

Only a brief résumé of some of the pertinent regional characteristics is offered here. As a basis for comparison, the most usable figure in the table is believed to be the annual sediment accumulation per unit of watershed, since this value represents effectively the "rate of sedimentation." The conditions governing this "rate of sedimentation" constitute a combination of the maze of factors affecting run-off and erosion, plus the additional factors of (1) upstream deposition and (2) by-passing of erosional debris entirely through the reservoir during high water stages. These latter factors govern the proportion of total soil washed from the land to that deposited in the reservoir. In effect then, the volumes of sediment listed in the table represent the volume of erosional debris from the

[1] Physical Science Aide, Section of Sedimentation Studies, Division of Research Soil Conservation Service, Washington, D. C.

Summary of Data on Reservoir Sedimentation in the Great Plains States

Name and location of reservoir	Age	Annual precipitation during life of reservoir	Watershed area	Original storage capacity	Storage capacity per square mile of watershed	Total volume of sediment	Annual loss of storage capacity	Annual sediment accumulation per acre of watershed
	Years	*Inches*	*Square miles*	*Acre-feet*	*Acre-feet*	*Acre-feet*	*Percent*	*Cubic feet*
Hurley, Potter County, S. Dak	4.5	10.35	70.0	1,226	17.51	37	0.67	7.97
Wellfleet, Lincoln County, Nebr	5.6	16.91	43.7	519	11.88	55	1.89	15.26
Hayes, Stanley County, S. Dak	4.2	10.87	40.0	629	15.73	49	1.86	19.91
Santa Fe, Butler County, Kans	8.6	27.66	40.0	1,741	43.53	146	.98	28.93
Ottawa County, Ottawa County, Kans	8.0	20.51	20.5	1,001	48.83	71	.89	29.48
Meade County, Meade County, Kans	8.8	17.74	18.0	891	49.50	72	.91	31.01
Eldorado, Butler County, Kans	8.8	29.82	33.0	3,213	97.36	131	.46	30.73
Olathe, Johnson County, Kans	5.1	31.08	7.0	532	76.00	55	2.03	105.01
Baker, Fallon County, Mont	29.1	14.07	5.18	756	145.95	254	1.15	114.32
Mission, Brown County, Kans	13.0	32.05	11.4	1,852	162.46	289	1.20	132.72

watershed minus (1) the volume involved in upstream deposition and (2) the volume lost by bypassing as suspended load. Obviously, therefore, the rate of sedimentation shown is merely a minimum rate of soil loss from the watershed.

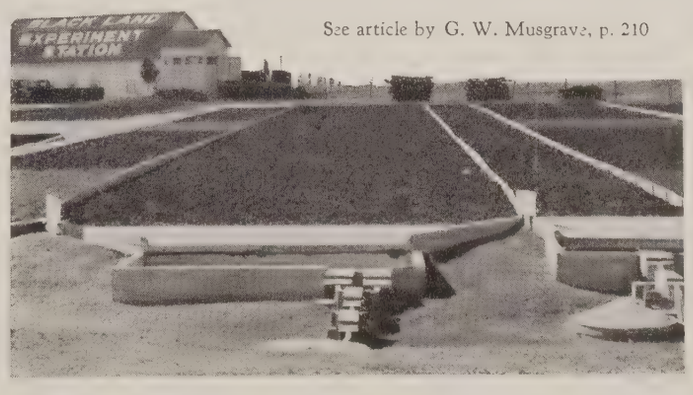
Reservoirs with a relatively small storage capacity per unit area of watershed, such as Lake Hurley and Wellfleet Lake, have a small capacity-inflow ratio and, as a result, flood flows pass through them with appreciable current. Consequently, only a fraction of the finer-grained erosional debris may be deposited, the rest being bypassed as suspended load. In a reservoir having a large capacity per unit area of watershed, a larger proportion of the incoming silt load will be deposited; in other words, the rate of sedimentation will ordinarily represent more closely the rate of erosion in the drainage area.

It is evident that the rate of sedimentation will not equal the rate of net watershed erosion unless the reservoir is capable of storing all the run-off from its watershed until complete desilting takes place. Such a condition is rarely achieved in reservoirs, the sole exception being some basins designed for irrigation or conservation storage. In contrast with other sections of the country, the average reservoir in this region is subjected to extensive fluctuation in water level because of prevailing climatic conditions, and stream flow is generally intermittent. It follows therefore that these reservoirs will tend to trap all the sediment during low run-off when no water passes the spillway, and bypass sediment only during periods of abnormally heavy flood flows. However, since reservoirs in the Great Plains States apparently accumulate an unduly large proportion of their total sediment during the irregular and infrequent periods of heavy run-off (Hayes Lake, for example, trapped 33 percent of its total sediment during one 48-hour flood flow), the reservoirs of the region do not have characteristic sedimentation rates dependent on total precipitation. The general correlation between the ages of the reservoirs and the rates of sedimentation, indicated in the table, may be a reflection of the number of these local intense rainfalls which have occurred in the individual watersheds during the life of the reservoir.

The other important factor, namely, the wide variation in extent of upstream deposition in individual watersheds, cannot be discussed here because of limited space. While the data would seem to indicate a tendency for the rate of sedimentation to vary inversely with size of drainage area, this relationship is not consistent, being influenced by the percentage of flat or gently sloping land in the watershed which is subject to sediment accumulation. Reconnaissance has indicated, however, that the average large watershed in this region includes a larger percentage of land subject to upstream deposition than does a small watershed.

Field research laboratory serving as a center of soil conservations investigations in the black land problem area in Texas.

See article by G. W. Musgrave, p. 210



BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

GROUND WATER. By C. F. Tolman. New York and London. 1937.

The author of this new and extensive book, who is professor of economic geology at Stanford University, has given us the first general treatise in the English language on the occurrence, motions, and activities of subsurface water, and the hydrologic properties of water-bearing materials. The text correlates scientific data from many sources, and summarizes the results of intensive studies of subsurface water in the western part of the United States. It is apparent to the reader that in writing the book Professor Tolman had in mind the need for water conservation to meet the periodic deficiency in water supply in semiarid regions and also the occasional severe droughts where rainfall and surface water are normally adequate. Most of the text deals with ground water in granular formations (alluvial and sedimentary deposits), tributary water in the atmosphere and on the ground surface, and water in the unsaturated zone above the water table. Water in superficial fractures and in the large openings in lavas and in soluble rocks is treated also as of importance in certain regions. Two chapters are devoted to the soil and the zone of aeration as background for the study of factors controlling influent seepage from rainfall and from streams, and water spreading to recharge ground-water reservoirs. The works of O. E. Meinzer on ground-water hydrology are quoted extensively.

Introductory to the detailed technical discussions to follow, Professor Tolman gives, in the first and second chapters, an historical account of the development of the ground-water theory and a résumé of the elements of ground-water hydrology. The latter includes discussions of states and origins of water, ground-water composition, natural reservoirs, the hydrologic cycle, the ground-water equation, geologic control of ground water, the zones of suspended water and saturation, movements of water in the zone of aeration and underground, wetting of clayey material with reference to slides and earth-fill dams, and free and confined water.

Rainfall and run-off are treated briefly but adequately to show the importance of meteorological data in determining stream run-off and stream flow. Methods of estimating evaporation and transpiration losses are illustrated by a description of investigations in Owens Valley, Calif., Escalante Valley, Utah, and in the Pomperaug Basin in Connecticut.

Meinzer's discussion of openings in rocks and the types of pore space which hold water is incorporated under the heading "Hydrologic Properties of Water-Bearing Materials, Except Soil," and this is followed up by detailed treatment of openings and the agencies that produce and destroy them, with a summary of Graton and Fraser's exhaustive treatise on the geometry of aggregates of spheres.

The soil is treated in a separate chapter and from the viewpoint of the ground-water scientist; i. e., "the root zone properly delimits the soil zone because the vertical perviousness produced by roots [and cracks and animal and insect burrowings] is one of the important hydrologic characteristics of the soil zone." Soil horizons are discussed briefly, as are seepage and percolation rates in soils, composition of soils, and classifications according to chemical environments, stages of formation, age, principal geologic processes active during formation, and mechanical analysis. The present scheme of classification of soil materials according to particle size as determined by mechanical analysis, by R. E. Davis and H. H. Bennett, is given as is also the equilateral triangle diagram devised by these two authors for indicating the physical composition of soils in connection with field mapping.

Capillary action is treated at some length under the chapter heading "Zone of Aeration." Included are some interesting charts showing the attractions acting on molecules at the surface of a liquid and on those at depth, movement of water in the capillary fringe, and rate and extent of capillary rise.

In a study of influent seepage, including water spreading to recharge ground water reservoirs, methods are described for investigating the continuity of pervious material from surface to water table by use of soil columns and lysimeters and tunnels; while measurement of influent seepage from streams is illustrated by investigations in the Mokelumne and Mimbres River valleys. Several methods of water spreading are described—check dams and other stream-bed improvements, ditches, the basin method.

Percolation and permeability are dealt with chiefly from the point of view of laboratory methods for measurement of velocity and flow in various materials and gradients. Darcy's law governing the relation between velocity of percolation, permeability of water-bearing materials, and water-table slope of free water or hydraulic gradient of confined water, is presented and discussed in some detail particularly in comparison with other formulae. Various permeameters are described, together with field methods for determining permeability and effective velocity.

The water table as occurring in granular material, and in fractures and solution openings, is treated separately because "the . . . 'laws' deduced for ground-water movements in granular materials are not of general application to water in fractures or in large tubular openings." Under the former the author explains the importance of the water table in ground-water investigations, and explains Darcy's law as combined with Meinzer's permeability coefficient for interpretation of water-table gradients. The development of water-table profiles and the effect of surface topography, varying permeability, and the impervious basement upon water-table gradients are treated introductory to the subjects of water-table maps and methods, electrical and geophysical, of locating the water table and bedrock. The section on electrical methods is contributed by J. J. Jakosky, and that on geophysical methods by C. A. Heiland. In the latter, the geologic-geophysical classification of ground water and of geophysical location methods is explained in concise terms and in detail.

Ground water in fractures and solution openings is discussed in a separate chapter as of importance locally and the chapter includes an interesting account of limestone beds—impervious flat-lying, impervious inclined, and porus.

The remainder of the volume is devoted to chapters on confined water, the geological classification of artesian aquifers, wells, oil field fluids, springs, the ground-water inventory, and ground-water provinces of the United States and the Hawaiian Islands. The unusually extensive references included throughout and the glossary of terms are distinctly helpful to the student in his reading of this general treatise.

RELATION OF SEDIMENTATION STUDIES

(*Continued from p. 222*)

sedimentation within the valleys.

(3) Investigations at field stations of the total sediment loads carried by natural streams; correlation of the different phases of these loads with the hydraulic functions of the streams and with the land use and topography of the watershed; establishment of empirical methods for the determination of the bed load carried by any stream; and studies of engineering methods for the control of the movement of sediment within a stream.

(4) Laboratory investigations of principles governing entrainment, transportation, and deposition of erosion debris by flowing water; the development of instruments for use in soil conservation investigations; and the solution, under laboratory controlled conditions, of problems originating in the field investigations.

U. S. GOVERNMENT PRINTING OFFICE: 1938

Useful Reports on Research Relating to Soil Fertility

For REFERENCE
Compiled by Mrs. ETTA G. ROGERS, Publications Unit

Field offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

Office of Information
U. S. Department of Agriculture

Physical and Chemical Characteristics of the Soils from the Erosion Experiment Stations—First Report. Bureau of Chemistry and Soils, U. S. Department of Agriculture. Technical Bulletin 316. June 1932.

The Physical and Chemical Characteristics of the Soils from the Erosion Experiment Stations—Second Report. Bureau of Chemistry and Soils, U. S. Department of Agriculture. Technical Bulletin 430. August 1934.

Base Exchange and Related Properties of the Colloids of Soils from the Erosion Experiment Stations—Third Report. Bureau of Chemistry and Soils, U. S. Department of Agriculture. Technical Bulletin 461. October 1934.

Selenium Occurrence in Certain Soils in the United States with a Discussion of Related Topics. Bureau of Chemistry and Soils, U. S. Department of Agriculture. Technical Bulletin 482. August 1935.

Trace Elements in the Soils from the Erosion Experiment Stations, with Supplementary Data on Other Soils—Fourth Report. Bureau of Chemistry and Soils, U. S. Department of Agriculture. Technical Bulletin 552. January 1937.

Some Moisture Relations of the Soils from the Erosion Experiment Stations—Fifth Report. Bureau of Chemistry and Soils, U. S. Department of Agriculture. Technical Bulletin 562. July 1937.

Agricultural Experiment Stations

Adapting Standard and High Analysis Fertilizers to Truck Crop Soils. Bulletin 316. Agricultural Experiment Station, State College Station, Raleigh, N. C. November 1937.

Agricultural Classification and Evaluation of North Carolina Soils, Including the Fertilization of Crops on Soil Groups. Bulletin 293. Agricultural Experiment Station, State College Station, Raleigh, N. C. February 1934.

Austrian Winter Peas and the Vetches for Fertilizer, Feed and Soil Protection. Bulletin 453. Extension Service, University of Georgia, Athens, Ga. August 1935.

Classification and Agricultural Value of New York Soils. Bulletin 619. Cornell Agricultural Experiment Station, Ithaca, N. Y. January 1935.

Conserving Soil With Natural Grass Waterways. Circular 362. Extension Service, University of Missouri, Columbia, Mo. April 1937.

Correcting the Unproductiveness of Acid and Alkaline Muck Soils for the Growing of Vegetable Crops. Bulletin 572. Cornell Agricultural Experiment Station, Ithaca, N. Y. June 1933.

Crop Adjustment: Oklahoma's Opportunity for Soil Improvement. Circular 307, General Series 82. Extension Service, Oklahoma Agricultural and Mechanical College, Stillwater, Okla. Reprint, 1935.

Easily Soluble Phosphorus in Oklahoma Soils. Bulletin 205. Agricultural Experiment Station, Stillwater, Okla. September 1932.

Effect of Soil Reaction on Growth, Yield, and Market Quality of Potatoes. Bulletin 664. Cornell Agricultural Experiment Station, Ithaca, N. Y. January 1937.

The Hydrolysis of Calcium Carbonate and Its Relation to the Alkalinity of Calcareous Soils. Technical Bulletin 64. Agricultural Experiment Station, Tucson, Ariz. October 15, 1936.

Influence of Crop Rotation and Soil Treatments Upon the Yield of Crops on Porter's Loam Soils. Bulletin 315. Agricultural Experiment Station, State College Station, Raleigh, N. C. November 1937.

Influence of Summer Cover on Nitrate and Organic Matter Content of a Poor Grade of Norfolk Soil. Part II of Effects of Summer Cover Crops on Crop Yields and on the Soil. Bulletin 301. Agricultural Experiment Station, Gainesville, Fla. September 1936.

A Key to the Soils of Ohio. Special Circular 44. Agricultural Experiment Station, Wooster, Ohio. 1934.

Lysimeter Investigations. IV: Water Movement, Soil Temperatures, and Root Activity Under Apple Trees. Technical Bulletin 237. Agricultural Experiment Station, Geneva, N. Y. October 1935.

Pertinent Points Concerning Soil and Its Management. Extension Bulletin 218. Extension Service, State College of Washington, Pullman, Wash. April 1936.

Preparation of Soil Profiles for Exhibition and Soil Study. Technical Bulletin 173. Agricultural Experiment Station, Geneva, N. Y. December 1930.

The Production of Corn on Richfield Silt Loam Soil. Panhandle Bulletin 62. Panhandle Agricultural Experiment Station, Goodwell, Okla. March 1937.

Reducing Soil Erosion Losses on Pennsylvania Farms. Circular 191. Agricultural Experiment Station, State College, Pa. August 1937.

The Relation of Certain Soil Characteristics to Forest Growth and Composition in the Northern Hardwood Forest of Northern Michigan. Technical Bulletin 135. Agricultural Experiment Station. East Lansing, Mich. September 1933.

Relation of Soil Acidity to Cotton Root Rot. Bulletin 545. Agricultural Experiment Station, College Station, Tex. June 1937.

The Significance of Nitrogen in Soil Organic Matter Relationships. Bulletin 206. Agricultural Experiment Station, Pullman, Wash. July 1926.

The Significance of Soil Types in Farming. Agricultural Education, vol. 13, Nos. 9–12. School of Vocational Education, Clemson Agricultural College, Clemson, S. C. May, June, July, and August 1937.

Soil Fertility Losses Under Missouri Conditions. Bulletin 324. Agricultural Experiment Station, Columbia, Mo. May 1933.

Soil Management for Kentucky. Circular 272. Extension Division, University of Kentucky, Lexington, Ky. April 1934.

Soil Profile Studies in Relation to Site Requirements of Black Locust and Black Walnut. Station note 31. Central States Forest Experiment Station, Columbus, Ohio. April 15, 1936.

Soil Temperature Studies with Cotton. I. Apparatus for the Control of Soil Temperature for Experimental Purposes. II. The Relation of Soil Temperature to the Germination and Growth of Cotton. Bulletin 189. Agricultural Experiment Station, Gainesville, Fla. September 1927.

Soils in Relation to Fruit Growing in New York. Part IX. Tree Behavior on Important Soil Profiles in the Newfane-Olcott Area, Niagara County. Bulletin 653. Cornell Agricultural Experiment Station, Ithaca, N. Y. July 1936.

Soils in Relation to Fruit Growing in New York. Part X. Susceptibility of Various New York Orchard Soils to Reduction Upon Water-Logging. Bulletin 667. Cornell Agricultural Experiment Station, Ithaca, N. Y. March 1937.

Soils of Collin, Frio, Galveston, Midland, Potter, and Van Zandt Counties and the Trans-Pecos Area. Bulletin 533. Agricultural Experiment Station, College Station, Tex. October 1936.

The Soils of Maryland. Bulletin 351. Agricultural Experiment Station, College Park, Md. July 1933.

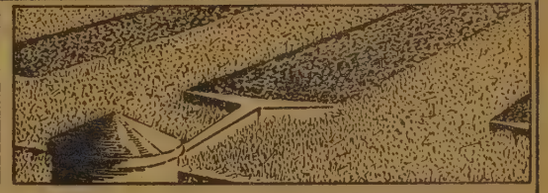
The Soils of Missouri. Bulletin 264. Agricultural Experiment Station, Columbia, Mo. January 1929.

Studies on Soil Structure: Some Physical Characteristics of Puddled Soils. Technical Bulletin 67. Agricultural Experiment Station, Tuscon, Ariz. June 15, 1937.

Winter Cover Crops for Pasture and Soil Conservation. Publication 188. Extension Service, University of Tennessee, Knoxville, Tenn. August 1935.

NOTE.—Additional references to soil fertility investigations may be consulted in the lists of recent publications which appeared in previous issues of SOIL CONSERVATION.

RESEARCH



STUDIES OF CLIMATIC AND PHYSIOGRAPHIC FACTORS OF EROSION

LEGEND

▲ CLIMATIC STUDIES ■ PHYSIOGRAPHIC STUDIES
● EROSION HISTORY STUDIES

ECONOMICS OF SOIL CONSERVATION

LEGEND

① NUMBER OF COOPERATIVE ECONOMIC STUDIES

SOIL AND MOISTURE CONSERVATION - LAND USE

LEGEND

■ OLD EXPERIMENT STATIONS ● INFILTRATION STUDIES
▲ NEW EXPERIMENT STATIONS ⊞ LABORATORY AND SUPPLEMENTARY STUDIES

SEDIMENTATION STUDIES

LEGEND

● RESERVOIR SILTING STUDIES ▲ STREAM AND VALLEY STUDIES
■ BED LOAD INSTALLATIONS ⊞ SEDIMENTATION HYDRAULIC LABORATORY

WATERSHED AND HYDROLOGIC STUDIES

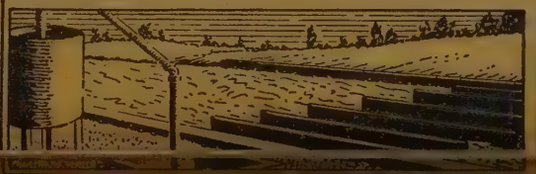
LEGEND

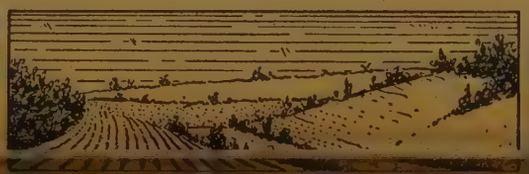
◆ INTENSIVE WATERSHED STUDIES
① NUMBER OF RUN-OFF WATERSHED STUDIES

HILLCULTURE

LEGEND

■ COOPERATIVE PROJECTS





S035
Cop 2

SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE · WASHINGTON

U. S. F. S. RECEIVED
LIBRARY
MAR 25 1938

HH5

MARCH
1938

Contents

The Opportunity Broadens: Page
By the Chief of the Soil Conservation Service 235

Youth and the Land:
By Robert Fechner 236

C. C. C. Operations:
By H. D. Abbott 237

The Enrollee and Soil Conservation:
By Brigadier General George P. Tyner 239

A Selecting Agency Views C. C. C. Work Opportunities:
By W. Frank Persons 240

How I Plan To Use Experience Acquired in an S. C. S.–C. C. C. Camp:
By Cecil O. Giesler 242

Enrollee Aid in Northeastern Orchards:
By James A. Seaman 243

Pioneers of Today:
By Ivy M. Howard 244

For Reference:
Compiled by Mrs. Etta G. Rogers ..... Opposite 246

WELLINGTON BRINK
EDITOR

SOIL CONSERVATION is issued monthly by SOIL CONSERVATION SERVICE of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. SOIL CONSERVATION seeks to supply to workers and cooperators of the Department of Agriculture engaged in soil conservation activities, information of especial help to them in the performance of their duties, and is issued to them free by law. Others may obtain copies from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of $1.00 per year, domestic; $1.40 per year, foreign. Postage stamps will not be accepted in payment.

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

VOL. III • NO. 9

H. H. BENNETT
Chief, Soil Conservation Service

MARCH • 1938

ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON

Terrace outlet channel in process of construction. Sod strips are to be placed in small transverse trenches.

The Opportunity Broadens

By the Chief of the Soil Conservation Service

DURING the past few years the attitude of those who use the land in America has undergone a remarkable change. Only a few years ago most of our farmers thought of soil erosion, if they thought of it at all, as an inevitable process of nature which caused them only inconvenience and irritation. They are now beginning to recognize that process as a very real peril to their own welfare, as well as that of the Nation, and to cope with it in a practical and effective manner.

This change has been brought about, in part at least, by a national program of soil conservation. In this undertaking, the Civilian Conservation Corps, working hand in hand with the Soil Conservation Service, has played a tremendously important part. By showing, in terms of actual work upon the land, that erosion can be controlled and that land can be used profitably for agricultural purposes and at the same time preserved for the use of future generations, these agencies have imbedded the principles of soil conservation deep in the roots of agriculture. America today has a sound foundation upon which to build for the future.

But the work of the Soil Conservation Service, and that segment of the C. C. C. which is engaged in soil conservation activity, has only begun. The task ahead, one that must be carried to successful completion if agriculture is to maintain its position in American life, is that of protecting all the land which needs protection from the wasteful and destructive effects of erosion. This in turn, because of the very vastness of our agricultural domain, cannot conceivably be accomplished for many years to come, nor can it be accomplished by any single agency, or group of agencies.

The task ahead is one that will require active soil-conservation effort on the part of all those who live on the land and use it for agricultural purposes. And recent events seem to indicate that American farmers are ready and willing to start on this undertaking.

During the past year a large number of States enacted soil-conservation districts laws which enable groups of farmers in natural land areas to form local organizations for purposes of soil defense. When organized, each district will have authority to carry on soil-conservation programs, and to accept technical and other assistance from those agencies which are prepared to extend such aid.

And as rapidly as districts are formed in those States which have suitable laws, the C. C. C. undoubtedly will be called upon to help the districts in planning and carrying forward their local programs. This single field today apparently offers the C. C. C. one of its greatest opportunities to perform services of lasting benefit to the Nation.

Youth and the Land

By Robert Fechner

Director, Civilian Conservation Corps

At work in a Soil Conservation Service nursery.

FOR many years before entering governmental work I had observed with growing concern the need for a conservation policy, and it was with deepest satisfaction that in 1933 I saw an aroused Government organize its forces to preserve natural resources. I was happy to have the privilege, through my connection with the C. C. C., of participating in the program.

When the Soil Conservation Service, now in the Department of Agriculture, was first established as the Soil Erosion Service under the Department of the Interior, a quarter of a million C. C. C. enrollees had already been working for a year on various programs of conservation. As director of the Civilian Conservation Corps I had been able to observe the tremendous benefits derived by the enrollees themselves from this type of work and at the same time to measure the progress of each program in actual work accomplishment. In 1 year, under the Park and Forest Service, enrollees had made commendable progress in rehabilitating forest areas, and I was convinced that through the Soil Conservation Service similar reclamation and conservation work could be extended to a much wider field. It was with enthusiasm, therefore, that I allocated C. C. C. camps to this Service, an activity which I believe to be one of the most valuable and interesting in which the Federal Government is engaged.

NOW, with 4 years of accomplishment to look back upon, it seems both desirable and fitting to review and evaluate the cooperative results so far obtained in this effort to save the soils of the country.

Created by act of Congress and with little precedent to guide it, the Civilian Conservation Corps came into existence when employment and discouragement were rife in the Nation. Bewildered youths, unable to obtain jobs, aimlessly plodded the highways from nowhere to nowhere. Likewise, the coming of the Soil Conservation Service found farmers in many sections of the country discouraged by their inability to prevent destructive soil erosion on their farms.

In 4 years the Soil Conservation Service has given new hope to farmers in every section of the country, while the Civilian Conservation Corps has established in the minds of youths a new faith in government. Technicians of the Service have demonstrated, on farm and range, that much land can be reclaimed and that erosion can be controlled. Profitable crops are now harvested on farms that once were unproductive. The discouraged farmer who watched his fields slowly washing down the hill toward the river has been given assistance and shown how this can be prevented. Many ranges are once more green and adequately support the herds. Dust bowls are being "anchored," and soils that before only shifted aimlessly in the wind are in many areas again producing crops and pasturage.

TO accomplish this work, hundreds of thousands of unemployed and discouraged boys have been taken into C. C. C. camps as enrollees. Understanding guidance, good food, and healthy labor under advantageous conditions have rebuilt bodies and character. Hope and confidence have been reestablished and boys with new viewpoints have been sent out into the world better equipped to fight life's battles and win. Grateful citizens and organizations throughout the country attest the courage, willingness, and ambition of these boys. They needed only opportunity.

I am convinced that the education in the camps of young enrollees from rural areas is one of the most valuable features of the C. C. C. organization; and, while it is true that the boys in all groups receive excellent experience which will be of general value to conservation in years to come, probably the greatest benefits come to those who are enrolled in soil-conservation camps. These boys learn not only how to conduct practical and efficient soil-erosion preventive measures but they learn actually to do the work themselves. It is safe to assume that these boys will be impressed with the importance of this work, and that they will be able to arouse interest and concern among their families and neighbors when they return to their homes.

With the splendid results before me, I feel that it is a work that should go on. It has heartened the farmer. It has offered opportunity to the enrollee and has given those dependent upon him much needed assistance. But the job is not done, and I see no reason for curtailing in the name of economy a work too long delayed and which if stopped would strike at the very heart of our economic structure.

C. C. C. Operations

By H. D. Abbott [1]

ON April 1, 1934, 22 Civilian Conservation Corps camps were assigned to the organization which later became the Soil Conservation Service. In less than 2 years, when the C. C. C. enrollment was at its peak, the number of camps had increased to more than 500. As limitations have since been placed on enrollment, the total has decreased until at the present time 361 camps are under the direct supervision of the Service.

Full responsibility for operation of these camps in the field is vested in the regional conservators, each of whom has a regional administrator, who with his assistants is directly responsible for C. C. C. administration. In order to ensure a coordinated work plan and to provide adequate technical direction, the camps are assigned to projects, the managers of which are responsible for outlining work programs. Each camp is under supervision of a superintendent, who has a staff of technicians and labor foremen to assist him. At the present time about 40 percent of the Service field personnel are C. C. C. employees, and a large majority of these men are located at camps directly engaged in planning and supervising the work of enrollees.

That the types of work required in soil conservation projects are well suited to the employment of enrollees is shown by the fact that during the fiscal year 1937 approximately 4 million acres of farm and range lands were treated by the camps. The nature of the work varies, of course, in different parts of the country; but this is also true, to a large extent, as regards the work between camps and even within each camp. A partial list of important operations which have been performed satisfactorily by enrollees in many parts of the country includes construction of terrace outlets and outlet structures, various forms of gully control, fence building, pasture sodding, seed collection, tree planting, nursery work, dam construction, stream-bank improvement, highway erosion-control demonstrations, construction of water spreaders, wind-erosion control, strip cropping, and improving wildlife habitats.

Erosion-control work is carried on by Soil Conservation Service C. C. C. camps in the same manner as on the watershed demonstration projects, the same type of cooperative agreement and identical conservation practices being used. While work has been demonstrational, it usually is not limited to a particular watershed area, although some of the camps are located on demonstration areas and others do considerable work on projects. Approximately 70 percent of the total acreage treated by the Service for the fiscal year 1937 was accomplished with camp labor.

Sloping sides of a recently excavated ditch preparatory to laying a rock masonry lining.

This coordination of the work of the camps with its regular program has enabled the Service to demonstrate a sound erosion control program to a vastly greater number of land owners than would have been possible without their assistance: since April 1, 1934, camps have been operated at 542 different locations in 39 States, while in the same period it has been possible to set up only 175 watershed demonstration areas. Camps have been placed at strategic points in sections where an erosion problem exists and where farmers were interested in cooperating with the Service in the checking of erosion by proper planning and practice.

Due to the nature of soil conservation work it has been difficult at times to find suitable employment for the more northern C. C. C. camps during winter months, but of late field officials have devised plans which promise to make this condition much more satisfactory. Stream-bank protection, woodland improvement, accumulation of materials for structures and fences, highway erosion-control demonstration, quarrying, fence building, clearing and cleaning for strip cropping and pasture improvement, protection

[1] Acting Assistant to the Chief, in charge of C. C. C. operations, Soil Conservation Service, Washington, D. C.

of wildlife—these are some of the operations which are to be stressed in the effort to make better use of enrollee labor during winter months.

There is no doubt whatever that thus far the association between the Civilian Conservation Corps and the Soil Conservation Service has proved mutually advantageous. While the camps constitute an invaluable contribution to the advancement of soil and water conservation, the training received by enrollees is extremely beneficial to them as individuals. Thousands of young men who came from farms have had the opportunity to learn sound farm planning and the application of approved conservation practices; this experience is certain to be put to practical use on the home farms. (Read Walter V. Kell's story, "New Life for the Old Farm," in the September 1937 issue of SOIL CONSERVATION.) Additional thousands of boys have received work training making them more employable and enabling them in many instances to secure jobs either within the Service or with commercial or industrial concerns. Many enrollees have become proficient in machine operation, truck driving, concrete work, drafting, use of instruments, plane-table work. A great many of our labor foremen, and some of our camp superintendents and camp technicians, are former enrollees. The establishment of conservation districts undoubtedly will afford employment in various phases of the work to outstanding enrollees. Already some of our boys have been employed by large landowners to assist in instituting soil-conservation practices.

The Service is justly proud of its C. C. C. safety record—the number of accidents has followed a continuous downward trend since January of 1936 when the records were begun. In that month the number of lost-time accidents in camps working under supervision of the Service was 4.63 per 1,000 enrollees; by September 1937 the frequency rate had been reduced to 1.53 per 1,000 enrollees. For the Corps as a whole the record shows a frequency rate of 18.0 per 1,000 enrollees for September 1934, and this was decreased to 9.5 by June of 1937. Calculation for the whole Corps is based on a 24-hour day, 7-day week exposure.

There is one very important type of work performed by the C. C. C. camps which does not affect directly the program of the Service. This is the emergency and rescue work, and every year the enrollees of our camps respond to calls of this kind in various areas. The great service rendered during the disastrous Mississippi and Ohio floods is well known. During those perilous times enrollees found many lost persons and rescued many others from drowning and freezing. They opened roads to permit transportation of doctors to those who were sick in snowbound homes and supplies of food to those in danger of starving. In some instances these opened roads established communication for whole communities which were snowbound and in danger.

While the technical service supervisory personnel is entirely responsible for the C. C. C. work program, there are other aspects of camp administration which are essential elements in the successful achievements of the organization. Enrollees must be housed, clothed, and fed. Health must be safeguarded. Enrollees must be taught the necessity of sanitation and how to live as members of a closely related group. Fortunately for the Corps, all these indispensable phases are handled by the United States Army personnel—the fine spirit of cooperation constantly exhibited by Army officers and technical service personnel is a compliment to all concerned. It is an outstanding example of interdepartmental cooperation and is an important contributing factor to the great success attained by the Corps.

As has been stated, the cooperation and assistance of the Corps has made it possible to extend very materially the valuable work of demonstrating to landowners the importance of soil conservation. The physical contribution of the Corps can be judged to some extent by the fact that up to and including September 30, 1937, 29,518,946 man-days of C. C. C. camp labor were devoted to soil-conservation operations on farm and range lands owned by cooperators. During this time some 300,000 young men, while supporting themselves and contributing to the support of dependents, have learned how to work—have received general work training and specific instruction making them more efficient, more employable, more useful citizens.

CROP MANAGEMENT AND SOIL CONSERVATION. By Joseph F. Cox and Lyman E. Jackson. New York and London. 1937.

This new text is dedicated to the future farmers of America and is designed especially for use by teachers of agriculture and conservation of croplands. It will be a useful book for the farmer who makes up his mind that he will improve his soils and at the same time make a satisfactory living off his acres. An introductory chapter gives a general plan for instruction, and part I of the main text deals with general crop-farm management problems. The second section of the volume is devoted to directions for growing specific crops—corn, wheat and rye, oats, barley, buckwheat and flax, sorghums, soybeans and cowpeas, clovers, alfalfa and lespedeza, grasses for hay and pasture, potatoes, fieldbeans, sugar beets and other root crops, special truck crops, home food and feed crops. The appendix contains varietal recommendations, listed by States, for production and soil improvement.—P. O. F.

Digging post holes for a fence on the farm of a Soil Conservation Service cooperator. The farmer furnished the materials.

The Enrollee and Soil Conservation

By Brigadier General George P. Tyner [1]

THE Civilian Conservation Corps was created to accomplish three principal objectives—the relief of unemployment, the performance of useful public work and, incidental to the first two but of no less importance, the betterment of the individual enrollee.

It is the betterment of the enrollee with which the War Department is primarily concerned—his development physically, mentally, and morally, so that upon his discharge from the Civilian Conservation Corps he will be a better citizen in every sense of the word than he was when he enrolled. With this object in view, he is given the opportunity of attending educational classes covering a wide range of subjects; he is encouraged to attend religious services regularly; he is imbued with a sense of discipline and respect for authority; and he is built up physically, by means of plentiful, substantial food and vigorous work out of doors.

The outdoor work of the enrollee, besides building him up physically, serves another valuable purpose. If the enrollee is ambitious and alive to his advantages, he is offered an excellent opportunity to learn a trade that will support him and his dependents after his discharge from the Civilian Conservation Corps.

This opportunity exists to a high degree in a Soil Conservation camp. The science of soil-erosion control is young, its exponents are pioneers, the fields open to their activities are almost limitless. An intelligent young man in a Soil Conservation camp is in a position to acquire a trade that may readily develop into a profession. Even if a boy spends the rest of his life on his own or his father's farm, the things he has learned in a Soil Conservation camp will be of inestimable value to him. But the field is broader than that. Actual cases are known where former enrollees have gone out as experts in erosion control and have made good in a big way. As the farmers of the country come more and more to a realization of the vital importance of erosion control, the demand for authoritative guidance is increasing and will continue to increase. One of the sources—perhaps the most prolific—from which trained conservationists will come is the corps of enrollees in Soil Conservation camps. A fine opportunity confronts them. If they are alert, they will seize it.

[1] U. S. Army, War Department representative on C. C. C. Advisory Council.

BRITISH GRASSES AND THEIR EMPLOYMENT IN AGRICULTURE. 3rd edition. By S. F. Armstrong. Cambridge and New York. 1937.

Part I deals with the botanical aspects of the grasses and includes keys for ready reference with plants grouped according to their inflorescences and floral characters and by their seeds. The second part of the book is the agricultural section. It has been considerably enlarged to include recent research investigations on the grasses and management of grasslands. The information regarding varieties or strains and their environment and seed supply is especially adaptable to regions other than Britain and the pasture management chapters could well be studied in connection with grassland problems in the United States. Useful references are included at the ends of chapters.—P. O. F.

47239—38——2

A Selecting Agency Views C.C.C. Work Opportunities

By W. Frank Persons [1]

SINCE 1933 the word "conservation" has assumed new and significant meanings in our economic and social vocabulary. It is more than a mental concept: it lives and moves ahead through agencies such as the Soil Conservation Service and the Civilian Conservation Corps.

For the quarter beginning January 1, 1938, the record shows that there are 360 C. C. C. camps throughout the United States devoting themselves to soil conservation. These camps employ some 64,800 enrollees, primarily young men between the ages of 17 and 23, selected from many local communities through agencies appointed by and affiliated with the Department of Labor. These lads furnish the essential man power for the work program. The Department of Labor and its selecting agencies, equally with the Soil Conservation Service are concerned with two eventualities of camp enrollment: The accomplishments of enrollees as workers and their personal development as individuals.

In Soil Conservation camps, as in all C. C. C. camps, the conservation and development of human resources proceeds step by step with the conservation and development of land resources. The C. C. C. work program deals with the two resources and both are of fundamental importance to the national well-being.

While the Civilian Conservation Corps must continue to be "work-centered," its program should justify itself on a broader basis than mere work "production." Work on the project should be utilized to the greatest degree possible also as a means to "instruction." The basic legislation itself states that the Corps is established "for the purpose of providing employment as well as vocational training."

To an increasing extent C. C. C. applicants tend to concentrate in the lower age brackets. At present about 75 percent are less than 20 years old. This means that the youths now being selected are relatively lacking in any kind of experience which would be useful to them in obtaining normal employment. Indeed, most of them have never held any regular continuing jobs. Industry and agriculture apparently are more ready to employ the kind of young men who "graduate" from C. C. C. camps, with their months of added maturity and experience, than the untrained youths who enter the Corps as new enrollees.

Enrollment should be, therefore, an experience whereby a youth is given a chance to develop good habits and attitudes about work, as well as an experience in which he may discover the kind of work for which he has an aptitude. It follows that the administrative and supervisory personnel on each project should accept as a primary objective the development of these enrollee attitudes and capacities to the maximum extent.

Eventually the great majority of enrollees return to the communities from which they are selected. More than half of them return to rural areas. Their gains in work experience, job morale, character, and citizenship will be noted by selecting agents, by employers, by their families and neighbors. Do C. C. C. enrollees profit as much as the land they have helped to conserve and protect? Are they more employable? The answers may depend upon the constant viewing and reviewing of the camp work program in terms of its human resource possibilities.

Without pursuing further this underlying philosophy I should like to outline the four essential devices for making Civilian Conservation Corps work opportunities more significant and helpful to enrollees while in camp. I do this not as a technical conservationist but as an observer, on behalf of the selecting agencies, of the needs of nearly 1,800,000 young men who have had C. C. C. experience since the enterprise began.

Try-out Assignments

On every project and in every Soil Conservation camp there is a wide variety of work to be done. When a new enrollee has been properly "placed" on work for which he is suited, it is of mutual advantage both to the worker and the work program. Thus upon entering the Corps he should be given try-out assignments and the opportunity to discuss his job preferences as well as his qualifications, with the project supervisor or foreman, until the type of available work to which he is best fitted has been determined—in other words, the type of available experience which will be most profitable to him.

But, since the Corps is also a training center and its members youthful and relatively inexperienced, job assignments should not be fixed and unchangeable. A

[1] NOTE.—Mr. Persons is Director of the U. S. Employment Service and in addition has served as the representative of the Department of Labor on the Advisory Council for the Civilian Conservation Corps since the beginning of the enterprise in 1933. In this capacity he has directed the selection of more than 1,800,000 young men who have served as enrollees in the Corps.

variety of work experience useful to the enrollee should be provided—at least within certain job groupings. There should be opportunity for an enrollee to shift out into other types of jobs which the camp affords. These rotations should not be decided casually. They may well result from discussion and review of the enrollee's qualifications by camp and project officials and with the enrollee himself—reserving to the using service the making of final assignments on the work project in the best interests of all concerned including the enrollee.

Understudies

Enrollment in the Corps has never been considered permanent employment. Neither should it be a haven of refuge for those who are lacking in ambition. It is expected rather that an enrollee will apply for discharge as soon as he receives the offer of a continuing outside job which will improve his condition and which he is qualified to hold. Many of the men also will leave voluntarily and return to their homes at the end of an enrollment period. For these reasons it seems self-evident that there must always be an understudy ready to fill another's place when separations occur. Such a plan protects the work program and, indeed, protects the enrollee in that he is not tempted, when ready for available employment elsewhere, to remain in the Corps on the theory that his services are indispensable to the project.

Enrollee Personnel Records

We cannot escape the necessity of measuring and recording the "output" of the Corps as to the increased employability of its members. The Federal Government will continue its investment in the Corps as a means of training inexperienced youths through actual work, largely because the measurable results of such a work program will be commensurate with the financial cost.

It would seem essential, therefore, that there be adequate records in each project office describing the actual duties performed by an enrollee during his term of service and including a rating of his competency in each type of work. Those characteristics which go to make up job morale should also be studied and rated; for instance, adaptability to changing processes and jobs—a factor of great importance today in private employment—dependability, initiative, and like qualities. Records of this type are of equal importance, if the Corps is to promote enrollee training, with work records showing how many rods of fence have been completed, how many check dams have been built, how much terracing has been done, how many square yards of sloping and sodding have been finished.

These personnel records should serve as a means of noting the training progress of an enrollee while in the Corps. Under established regulations, the project superintendent may also certify this record to the company commander for inclusion on the discharge certificate. A copy of the record might be forwarded, where requested, to another project superintendent if the enrollee is transferred to another company in the Corps, to a prospective employer, or to a public employment office.

The following excellent statement quoted from a recent issue of the New Hampshire State Employment Service News is in point as to the need of exact records. It is contained in an article by interviewer Paul Tracy, formerly commanding officer of a New England C. C. C. camp and thus well acquainted with the Corps:

> In the next few months [Employment Service] interviewers are bound to have ever-increasing contacts with young men whose sole work experience has been in connection with the Civilian Conservation Corps. Upon the interviewer falls the duty of determining the classification for each individual for which he may be best fitted and in which there is the best opportunity of his obtaining employment . . . It can be safely said that at least 75 percent of all C. C. C. enrollees leave camp better suited and better equipped to find a job than when they first left home to enter the Civilian Conservation Corps. Hence, the task of the interviewer in registering or reinterviewing a former C. C. C. member resolves itself into two definite phases—first, a determination of the exact duty or duties performed by the young man in camp and, second, the interpretation of that work experience into the same or similar job classification in private industry.

The new emphasis being placed on the work-training program of the Civilian Conservation Corps is a tremendous advantage to the selecting agencies. It will result in greater stability of enrollee interest in the Corps and greater social dividends to the local community as the man returns to his home upon completion of his service. A further and equally important outcome will be the greater attractiveness of the Corps to new applicants. Because of the opportunities it affords, enrollment in the Corps will be coveted by all young men in the numerically eligible group. A more qualitative selection will result. Thus the work program will improve, and work production will increase in direct ratio to the appeal of the Civilian Conservation Corps to young men who now comprise its strength, as well as to those potential enrollees who now knock at the selecting agency door.

CORRECTION.—On page 220 of the February issue the picture of Boulder Dam was mistakenly described as Elephant Butte Dam.

How I Plan to Use Experience Acquired In An S. C. S.-C. C. C. Camp

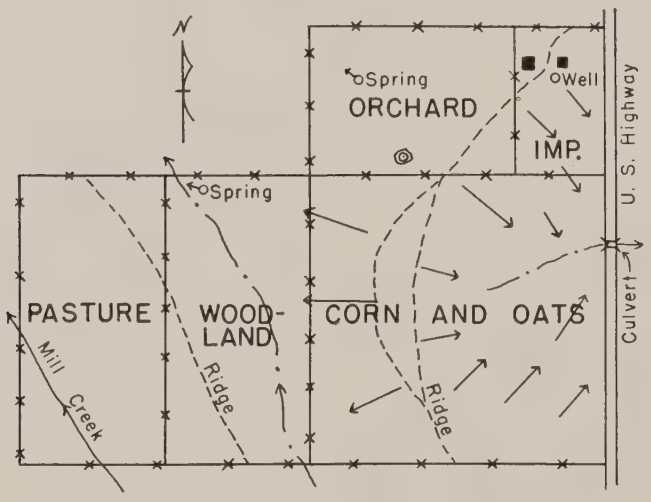
By Cecil O. Giesler [1]

Cecil O. Giesler.

HAVING come from a farm, and since I plan to return to it when I leave the C. C. C., I consider myself very fortunate in being assigned to an S. C. S.-C. C. C. camp.

All my life I have wanted to learn more about how I could improve the handling of our small farm, but going to college was out of the question for me. I had no idea when I joined the C. C. C. that it would be my good fortune to be assigned to Camp SCS–MO–12 at Paris, Mo., where I could learn in the most practical way the very things I felt I should know to make a success of farming.

Land-use map of farm at present time.



I live on my father's farm located near Vichy, Mo., in Maries County. When I leave the C. C. C. camp, I will have 100 acres of land under my management. Because of things I have learned in camp I feel sure I can do a much better job of conserving fertility of the soil and protecting it from the serious erosion it has had to endure in the past. I feel sure I can also make better use of our land, as I have observed methods used in Monroe County on farms similar to ours where the camp has established soil and moisture conservation demonstrations on 120 farms.

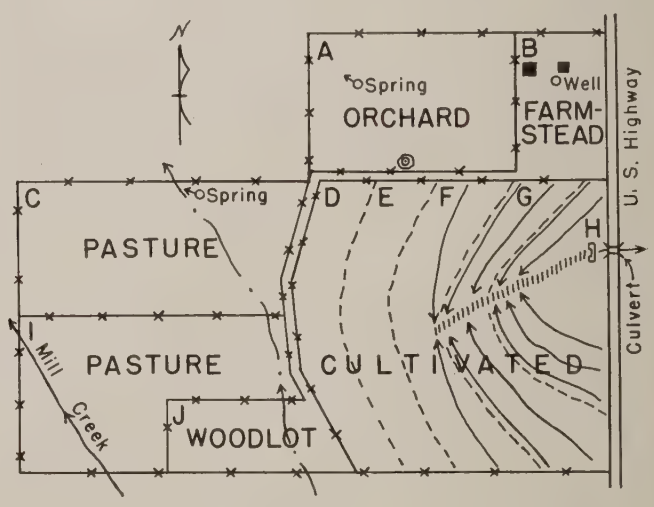
I have consulted our camp agronomist, camp engineer, and camp superintendent, and have made up a complete land-use program which I plan to put into effect on our farm when I return to it. We have 40 acres of cropland, 20 acres of bluegrass pasture land, 20 acres of woodland, and 20 acres on which our house and barns, truck gardens, and orchard are located.

Our farm, as practically all the other farm land in that locality, is rolling to steeply rolling. I want to terrace the entire 40 acres of cropland to check erosion and to conserve moisture. We have a natural swale through the 40 to use as a terrace outlet when proper vegetation is established. I may have to build a permanent rock structure or two in this outlet, but, since I helped my foreman supervise the construction of a number of such structures, I am sure that I will know how to do that.

Since I expect to farm all my cropland on the contour, I will have to change the fence between the cropland and woodland and place it on the contour. In order to secure the necessary 5-year rotation of crops on this land, I think I should divide it into five fields of about 8 acres each and put such fences on the contour also. I have observed, and Monroe County

(*Continued on p. 246*)

Land-use map of farm as planned by Cecil O. Giesler, C. C. C. enrollee.



Fields:	*Acres*
A	13
B	6
C	17
D	8
E	8
F	8
G	8
H	8
I	17
J	5
Barnlot, etc	2
Total	100

[1] Enrollee in Camp SCS–MO–12, Paris, Mo.

Enrollee Aid In Northeastern Orchards

By James A. Seaman [1]

SEVERAL of the Region 1 projects of the Service are located in important fruit-growing sections. During the last 3 years a great deal of work has been done on these projects to apply erosion-control methods to orchards.

Generally the orchards are classed as sod orchards or clean-tilled orchards, and both types present separate erosion-control problems. Added to this, other factors such as slope, soil type, and amount of rainfall enter into the picture. The complexity of the problem calls for many different control practices and provides a variety of work for the C. C. C. enrollees working under the direction of the Service.

A good sod in an orchard is a big step toward the control of erosion. With this in view the C. C. C. boys have been quarrying limestone to be pulverized and burned and later used on the soil by the cooperator who wants to establish and maintain a good sod on his orchard land. On some farms, due to the steepness of slope or to slope causing a concentration of water, or to poor turf, it is necessary to build diversion ditches or terraces to intercept the water and carry it to a place where it will do no damage. Many of the diversion terraces are built by machines manned by enrollees who are trained to do the work and are kept constantly at it. In some orchards, because of the nearness of the ditches to fruit trees, portions of the ditches must be built by hand.

The clean-tilled orchard is a more serious problem and, except for the use of single and double annual crops, erosion must be controlled almost entirely by engineering structures such as diversion terraces, contour furrows, outlets, and check dams. In established orchards this work usually is imperative and it presents a very difficult study to the engineers in laying out their structures so that it will not be necessary to remove many trees.

In the clean-tilled orchards the C. C. C. enrollees build check dams, terraces, diversion ditches, and outlets. To heal gullies, temporary check dams ordinarily are used, but it is often necessary to construct permanent masonry dams in drainage ways to take care of the run-off. Where it is possible the diversion ditches and terraces are built by machinery; in established orchards, however, it is often necessary to resort to hand work. Also, where possible, the terraces and diversion ditches are emptied into natural channels; but otherwise waterways or outlets must be built and protected with a heavy sod. Where the slope is too great for sod protection the outlets are riprapped or paved with stone.

Most orchards are planted on the square, rectangular, or hexagonal system, causing some rows to run up and down hill. The Soil Conservation Service is now advocating and including in the cooperative agreements a new system of planting orchards. It is the contour system. The field to be planted is laid out by the engineer assisted by the C. C. C. enrollees. All trees are planted on the contour. The engineering structures can be built either before or after the trees are planted. Any cultivation operations in an orchard planted in this manner can be done on the contour and, instead of harrow marks running up and down hill as insipient gullies they, with the small furrows, are on the level where they retard the downward flow of water. After a few years of cultivation, a bench forms between each row of trees, and this aids further in retarding the run-off and gives soil more time to take up the water.

In established orchards, most of the work is done in the late fall, winter, and early spring. This is an advantage both to the fruit grower and to the Service. When the trees are dormant there is less damage done by the workers and, at the same time, there is less interference with the grower's work. Most of the orchard improvement work in which the C. C. C. participates is done in the winter when other farm operations are at a standstill.

FOREST BIBLIOGRAPHY TO 31ST DECEMBER 1933. University of Oxford. 1937.

Parts I and II of a bibliography series of forestry and silviculture articles, annals, memoirs, manuals, technical publications, etc. Comprising literature appearing throughout the past century and now contained in the library of the department of forestry, Oxford University, England. Part I: General forestry, classified by countries, and silviculture in general and silviculture of seed and seedlings. Part II: Continuing the subject of silviculture under the headings: (1) Natural reproduction, (2) Artificial reproduction, (3) Tending, (4) Silvicultural systems, (5) Notes on trees. Brief particulars characterizing contents of all articles are appended—an important time-saving feature. The bibliography will be extremely valuable to students and organizations engaged in solving the problems of forestry and to research ecologists.

—P. O. F.

---

[1] Superintendent, Camp SCS-Pa-4, Waynesboro, Pa.

Pioneers of Today

By Ivy M. Howard [1]

Planting willow slips for living dams to replace wire checks after they have served their purpose.

POST OFFICE OAK and Council Oak, two great trees standing only a few rods apart in what is now Council Grove, Kans., have witnessed a strange pageant—more than a century of American development. Indian arrows have whistled through their boughs, speeding to the hearts of early settlers. The first school for white children in what is now Kansas, was located within a stone's throw of the trees. A city was built around them. Babies crying for food because of drought have been cooled in the shadows of the mighty oaks. Flood waters from the Neosho have marked these great trees with dirt rings. Today the well-preserved old oaks whistle tunes of many cadences—some stirring, some mournful—but in the evenings they grow still, listening to the earnest conversations of passing C. C. C. boys who talk of erosion control and moisture conservation—new topics for the ancient trees.

Under Post Office and Council Oaks has passed many times Herschel M. Klotz, 24-year-old farm youth from Chase County. But after March 31, the oaks will hear his voice no more. Then Klotz will go back to the farm whence he came. He will go back with new knowledge of soil conservation and a determination to put into use many of the erosion-control practices he has learned in the 2 years of camp life.

THAT things happen and happen fast in C. C. C. camps is shown by a statement from Klotz. "It was Saturday when I reached camp, and Monday at noon the assistant camp engineer came into the barracks and asked if any of us knew how to do survey work. No one did. I spoke up and asked if he would teach me and let me take a place on the survey crew. That's how I happened to get on the crew so soon."

Drought with its subsequent low yields made it necessary for Klotz to enter a C. C. C. camp, but he says in all sincerity that his main reason for enrolling was to learn how to control erosion.

"Before coming to the camp," the youthful conservationist says, "I spent many days hauling rock to gullies and piling them so the centers of the checks would be highest. Now I know that the center of a gully check should always be lowest. Before I came to the camp I thought a terrace should be built and an outlet provided later. Now I know the outlet must come first."

For an hour Klotz enumerated things he has learned about soil conservation as an enrollee in the Council Grove Soil Conservation Service C. C. C. camp. He told of attending educational classes where erosion-control practices were taught, of reading books and Bulletins on soil conservation and of bumping into problems in the field that taught him much. Klotz, like thousands of other boys, is proud of his knowledge—knowledge that was not available in the younger days of the Post Office Oak and the Council Oak.

PIONEERS indeed are the C. C. C. enrollees who are fighting erosion in the Great Plains States. Trails blazed by them will be followed for generations. The work, while valuable to the farmers on whose land it is done, will be even more so to the farmers' children and their children's children. In Oklahoma alone, 2,000,000 acres, once cultivated, now lie bare and abandoned—so riddled by gullies that the Indians who once claimed the land as a happy hunting ground would now find it useful only as a burying ground. The work the C. C. C. boys are doing in demonstrating effective methods of erosion control promises to save additional millions of acres of land from the same fate.

North from the Santa Fe Trail to the northern boundary of Nebraska and south to the Oklahoma-Texas line enrollees of the 44 C. C. C. camps under the

[1] Section of Information, Soil Conservation Service, Salina, Kans.

supervision of the Soil Conservation Service are engaged in putting on demonstrations of erosion control practices in limited areas, just as is being done on project areas. The work is the same that is being done on projects; the results are in every way comparable to those on demonstration erosion control projects; and the number of persons who visit the C. C. C. demonstrations in Region 7 is far greater than those who visit project areas. In 1937 more than 50,000 farmers left their work to see farm pond dams riprapped by C. C. C. boys; to observe the effects of contour pasture furrows and ridges the boys had helped build; to discuss the advantages of terraces, contour rows, and strip cropping for which C. C. C. boys had surveyed lines; to examine gully checks made by the enrollees—in short to see complete programs of erosion control made possible by the unflagging efforts of boys who are learning to conserve America by conserving soil and moisture.

In the Pawnee City, Nebr., camp, a camp with an outstanding educational and work program, the foremen use cooperative agreements as textbooks in teaching soil conservation to the enrollees who are working on the farms. This ensures the boys practical as well as scientific training in solving problems of soil and water conservation on farms.

The two old oaks hear conversations and learn that most of the new enrollees are from farms to which, in the beginning, they hope never to return. But the boys are sent to eroding farms where they work day after day and gradually grasp the significance of the methods. Stretching barbed wire around the gullied areas they find more than mere employment for which they are paid $30 per month with food, clothes, and shelter. They learn that their work means cooperation with Nature. They are helping to make of the abused land a haven for wildlife and a source of income for future generations. They see good reasons for doing other types of work too, and were the oaks articulate they would say that soon after the boys enter camp they are talking about methods that can be applied on their own farms; and that when enrollment periods expire thousands, like Klotz, actually go home to use and teach others to use soil- and moisture-conservation practices in their own communities.

Appreciation of the value of erosion-control work among enrollees is well demonstrated by the course of action pursued by Otis U. Rich, a member of the Ottawa, Kans., veterans' camp. In November 1936 Rich spent his bonus for a farm—an 80-acre farm located on the Soil Conservation Service demonstration erosion-control project in Franklin County, Kans. Immediately he contacted the Soil Conservation Service technical men and asked that a 5-year program of erosion control be worked out for the farm. A program was promptly outlined and Rich started using soil- and moisture-saving practices. In 1937 every row on the Rich farm was on the contour; a good crop rotation was started; pasture land was protected from fire and overgrazing; and a farm pond was built, with a 235-acre watershed protected by grass and terraces.

"Working in a camp engaged in erosion control made me realize the value of the work," Rich says. "Before I entered the camp I knew something should be done to control erosion on farms, but I did not know just what. Now I realize that contour farming, the use of soil-holding crops, terraces where needed, and gully control by means of diversion ditches are all steps that help hold soil."

Civilian Conservation Corps workers of Region 7 are contributing to soil conservation in three major ways:

(1) They are doing work on individual farms that will reduce soil losses on those farms;

(2) They are demonstrating erosion-control practices so that others may see the value of conserving soil and moisture;

(3) They are learning fundamentals of erosion control and taking the knowledge back to their own communities and to places far remote from any demonstrational area.

That these pioneers of soil saving are in demand is indicated by repeated requests received by camp superintendents to recommend boys for farm work. Here is a specific example chosen from hundreds that might be cited: A farmer near Madison, Nebr., asked the superintendent of the Madison Soil Conservation Service C. C. C. camp to send to him a boy who could establish soil-conservation work on his farm. Harold Carlson was recommended. He went to the farm at a salary of $65 a month. That was about a year ago. Now Carlson is married and in addition to the $65 per month his house, fuel, milk, and meat are furnished—proof enough that the soil-conservation work Carlson is doing on the farm has the approval of the farm owner.

In Blackwell, Okla., an owner of many farms insists that her tenants and farm hands be C. C. C. boys who have been in camp one or more enrollment periods. The boys know how to take care of her farms and they become long-time lessees, she points out. In other camp areas, there is the same demand for C. C. C. boys on farms.

Also there is a field for the better-trained boys in agricultural leadership. Paul Pittman of Garfield

Planting trees in contour rows on slope which is to be retired to woodland.

County, Okla., is an example. When he left camp he learned that the Garfield County agricultural agent was swamped with requests for lines for contour farming and for terraces. Having served as a member of a survey crew in camp, Pittman knew he could do the work the farmers wanted done. He went out to see some of them. They said they would be glad to pay him the same salary, for half-time work, that he had received while in camp for full-time work. This sent Pittman on his way to agricultural leadership and marked another contribution on the part of the C. C. C. to soil conservation.

White and black, old and young, enrollees of C. C. C. camps in Oklahoma, Kansas, and Nebraska are making definite contributions to soil conservation as they pioneer in the field of erosion control. They come to camps from scattered areas, learn erosion-control practices, and take their knowledge to their home communities. Records of the birthplaces of veteran enrollees of the Ottawa, Kans., camp show that the men came from 22 States and three foreign countries. In other camps similar records are found.

The assistance which C. C. C. enrollees have given farmers of Region 7 in building many miles of terraces, riprapping dams of farm ponds, and in doing many other important soil-conservation jobs constitutes only a small part of their contribution. The greatest work of all, results of which will outlive both the Council and Post Office Oaks, is that of learning and teaching erosion-control practices.

TO USE EXPERIENCE

(*Continued from p. 242*)

farmers testify, that contour farming certainly saves soil and increases the yield because of the saving of moisture.

Before planning my crop rotations, I'll consult the farm agent of my county, but my own idea is that by dividing the 40 acres into five fields, I could run a 5-year crop rotation of corn, oats, wheat 1 year each, then sweetclover, lespedeza, timothy, and possibly some red top, for 2 years. I hope to be able to lime this 40 acres and to fertilize it at the rate of 200 pounds of phosphate fertilizer per acre on winter small-grain seedings to increase the yield and to help establish the grass seeding.

I shall divide the 20 acres of pasture into two fields so that I can rotate the grazing and prevent overgrazing. I also intend to mow them in June and August to help control weeds and buckbrush. In the spring, I shall add about 10 pounds of lespedeza disked in, using some fine lime with this, if I can get it. I plan to do all I can to improve our pastures because I think that, if handled right, the pasture land may return the greatest net profit.

Having learned in camp that proper woodland management can add much value to a farm, I shall do what no one has been paying much attention to in my part of the country—that is, give protection to the growing timber. I shall select a portion of the best timber and fence it off and take care of it as I would any other farm crop. I intend to keep livestock away from it, protect it from fire, and select the trees I cut for fuel, leaving the better trees to provide posts and necessary sawlogs for farm use in coming years.

I have also learned something about keeping farm accounts while in the C. C. C. camp and I am going to ask the extension service of the Missouri College of Agriculture to provide me with the necessary farm-account forms so that I can keep close record of my farming business.

I may have some difficulty in financing all my plans, but I am determined to carry them out, if possible.

U. S. GOVERNMENT PRINTING OFFICE: 1938

Crops and Fertilizers Used in Erosion Control Program

For REFERENCE
Compiled by Mrs. ETTA G. ROGERS, Publications Unit

Field offices should submit requests on Form SCS–37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

Office of Information U. S. Department of Agriculture

Green Manuring. Farmers' Bulletin 1250. Bureau of Plant Industry. April 1925. 5c.[1]

Effect of Alfalfa and Farm Manure on Yields of Irrigated Crops in the Great Plains. Technical Bulletin 483. Bureau of Plant Industry. September 1935. 5c.[1]

Winter Legumes for Green Manure in the Cotton Belt. Farmers' Bulletin 1663. Bureau of Plant Industry and Bureau of Agricultural Economics. April 1931.

Summer Crops for Green Manure and Soil Improvement. Farmers' Bulletin 1750. Bureau of Plant Industry. September 1935.

Agricultural Experiment Stations

Alfalfa and Sweet Clover on Irrigated Land. Bulletin 158. Extension Service, State College of Washington, Pullman, Wash. June 1930.

Alfalfa in Ohio. Bulletin 540. Agricultural Experiment Station, Wooster, Ohio. September 1934.

Angleton Grass. Bulletin 342. Agricultural Experiment Station, College Station, Tex. June 1926.

Annual Forage Crops Under Irrigation. Bulletin 261. Agricultural Experiment Station, Bozeman, Mont. April 1932.

Crested Wheatgrass. Circular 66. Extension Service, Montana State College, Bozeman, Mont. June 1934.

Crop Response to Lime and Fertilizer on Muck Soil. Bulletin 292. Agricultural Experiment Station, State College Station, Raleigh, N. C. January 1934.

Crop Rotations for Piedmont Counties. Extension Circular 39. Extension Service. Clemson Agricultural College, Clemson College, S. C. September 1922.

Crop Yields from Illinois Soil Experiment Fields, Including the Crop Season 1935. Bulletin 425. Agricultural Experiment Station, Urbana, Ill. July 1936.

Crops to Replace Spring Wheat in Northern Idaho. Bulletin 177. Agricultural Experiment Station, Moscow, Idaho. February 1931.

Cultural Practices for Alfalfa in Northern Idaho. Circular 72. Agricultural Experiment Station, Moscow, Idaho. March 1934.

Effect of Calcium and Phosphorus Content of Various Soil Series in Western Washington Upon the Calcium and Phosphorus Composition of Oats, Red Clover, and White Clover. Bulletin 243. Agricultural Experiment Station, Pullman, Wash. June 1930.

Effect of Fertilizers and Cropping Upon the Nature and Amount of Electrodialyzable Bases in the Soil with Particular Reference to Potassium. Bulletin 200, Technical 17. Agricultural Experiment Station, Newark, Del. May 1936.

Effect of Frequent Cutting and Nitrate Fertilization on the Growth Behavior and Relative Composition of Pasture Grasses. Bulletin 269. Agricultural Experiment Station, Gainesville, Fla. July 1934.

Fertility Maintenance by Rotation and Manure. Bulletin 271. Agricultural Experiment Station, Logan, Utah. March 1936.

Fertilizer and Crop Experiments on Certain Soils of the Black Belt. Circular 78. Agricultural Experiment Station, Auburn, Ala. July 1937.

Fertilizer Experiments with Cotton on Heavy Irrigated Soils. Bulletin 248. Agricultural Experiment Station, State College, N. Mex. May 1937.

Fertilizer Experiments with Hay Crops in the Connecticut Valley. Circular 50. Agricultural Experiment Station, Durham, N. H. June 1936.

Fertilizer Rotation Experiments at the Pee Dee Station. Bulletin 262. Agricultural Experiment Station, Clemson Agricultural College, Clemson College, S. C. November 1929.

Fertilizer Tests on an Important Pasture Soil Type. Bulletin 306. Agricultural Experiment Station, Amherst, Mass. January 1934.

Fertilizers and Cover Crops on Soils in the Irrigated Orchards of Washington. Bulletin 217. Agricultural Experiment Station, Pullman, Wash. August 1927.

Forage Crops for the Non-Irrigated Lands of Idaho. Bulletin 120. Agricultural Experiment Station, Moscow, Idaho. March 1920.

Influence of Systems of Cropping and Methods of Culture on Surface Run-off and Soil Erosion. Research Bulletin 177. Agricultural Experiment Station, Columbia, Mo. November 1932.

Meadow Improvement Through Seeding, Fertilization, and Management. Bulletin 181. Cornell University, Ithaca, N. Y. June 1929, revised March 1936.

Minor Elements and Crop Fertilization. Circular 168. Agricultural Experiment Station, Geneva, N. Y. July 1937.

Pasture Fertilization. Bulletin 323. Pennsylvania State College, State College, Pa. (In cooperation with the Bureau of Plant Industry, U. S. Department of Agriculture.) September 1935.

Seed Treatments for Farm Crops. Circular 444. Agricultural Experiment Station, Urbana, Ill. January 1936.

Silage Crops for Nevada. Bulletin 91. Agricultural Experiment Station, Reno, Nev. February 1918.

Soil and Fertilizer Studies by Means of the Neubauer Method. Bulletin 399. Agricultural Experiment Station, La Fayette, Ind. March 1935.

Some Effects of Long-Continued Manure, Fertilizer, and Lime Treatment on the Composition of Cropped Soils. Bulletin 604. Agricultural Experiment Station, New Brunswick, N. J. June 1936.

A Study of Influence of Depth of Ground-Water Level on Yields of Crops Grown on Peat Lands. Bulletin 330. Agricultural Experiment Station, University Farm, St. Paul, Minn. August 1936.

Thirteen Years' Results With Cover Crops. Bulletin 275. Agricultural Experiment Station, Morgantown, W. Va. June 1936.

Use of Green Manures in Soil Improvement. Extension Circular 280. Extension Service, College of Agriculture, Columbia, Mo. 1931.

Winter Cover Crop Experiments at the Pee Dee Experiment Station. Circular 51. Agricultural Experiment Station, Clemson Agricultural College, Clemson College, S. C. September 1933.

---

[1] From the Superintendent of Documents, U. S. Government Printing Office Washington, D. C.

NOTE.—For additional references, see previous lists in SOIL CONSERVATION.

WHAT THE CCC ENROLLEES HAVE DONE IN SOIL CONSERVATION

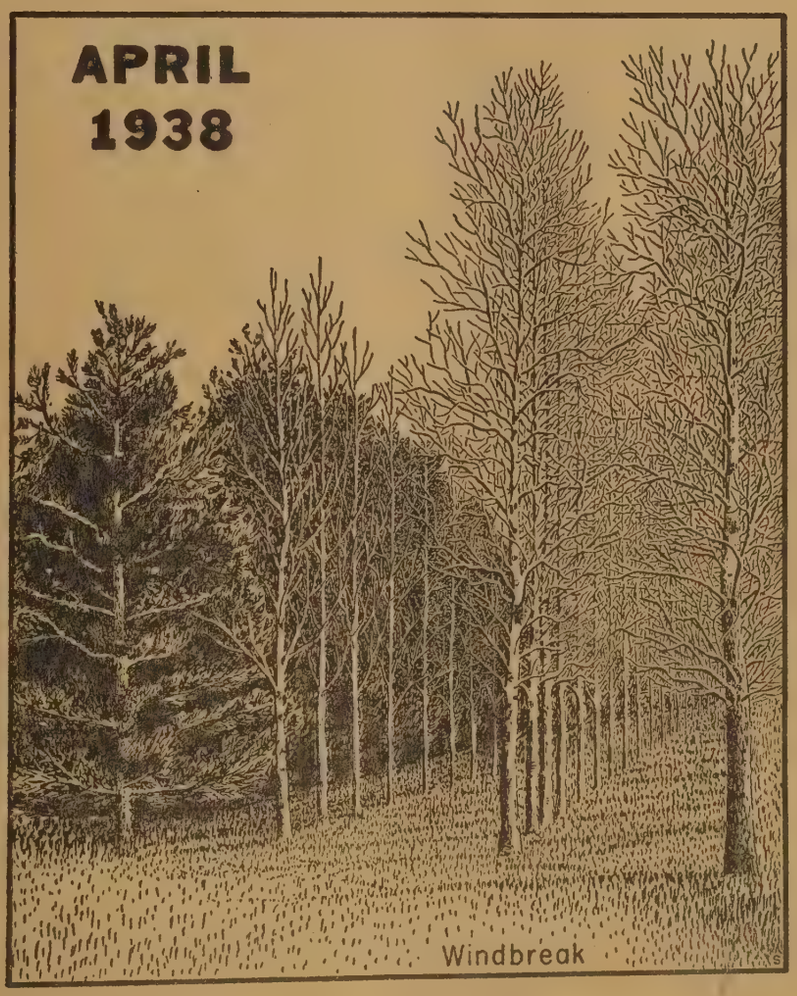
So 3S.

U. S. F. S. RECEIVED
LIBRARY
APR 18 938

SOIL CONSERVATION

FFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
NITED STATES DEPARTMENT OF AGRICULTURE · WASHINGTON

APRIL
1938



Contents

Windbreaks Help Control Erosion in the Great Plains

By George W. Hood

(See page 247)

Humus and Soil Conservation

By Selman A. Waksman

(See page 250)

Research Contributions to Wind Erosion Control

By H. H. Finnell

(See page 255)

WELLINGTON BRINK
EDITOR

Soil Conservation is issued monthly by Soil Conservation Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. Soil Conservation seeks to supply to workers and cooperators of the Department of Agriculture engaged in soil conservation activities, information of especial help to them in the performance of their duties, and is issued to them free by law. Others may obtain copies from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of $1.00 per year, domestic; $1.40 per year, foreign. Postage stamps will not be accepted in payment.

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

VOL. III • NO. 10

H. H. BENNETT
Chief, Soil Conservation Service

APRIL • 1938

ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON

This corn on the farm of J. J. Lydeck, near Craig, Nebr., is protected on the south by a tall windbreak planting and will yield from 60 to 70 bushels per acre.

Windbreaks Help Control Erosion in the Great Plains

By George W. Hood [1]

THE VALUE of trees in the Great Plains has been recognized for more than a hundred years. During that time, millions of shrubs and trees were planted. In pioneer days they were considered an essential feature of the prairie home. They protected the farmsteads from the chilling winds and drifting snows of winter and checked the withering blasts of hot, dry summer. Trees increased the value of prairie and plains farms.

Many good things are not understood until they are lost, and so it has been with the trees. During the past few years large numbers of the trees on the Great Plains have perished because of adverse weather conditions, drought, and grasshopper injury. Many others disappeared because they had reached their natural span of life and farmers did not realize that trees require maintenance just as do other types of farm investment. A farm windbreak, for example, once it is established, requires care and management if it is to be permanent. Trees mature and die and must be replaced by new plantings and this must be followed up with cultivation and thinnings. The life cycle of birth, growth, and decay applies to trees as to all living things and on the plains artificial replacement often must take the place of natural reproduction which under more favorable conditions for tree growth, is Nature's method of perpetuation.

The early settlers on the plains migrated from the East. Trees were a part of their life, and when they moved to the plains their first impulse was to plant

[1] Regional Forester, Soil Conservation Service, Salina, Kans.

trees. Such plantings were early recognized as protection to the home and stock but it was some years before the farmers realized their value as shields for fields planted to crops and that their use resulted in increased yields. This benefit from windbreaks is now fully recognized.

Perhaps no better example of the beneficent influence of windbreaks can be found than that on the farm of J. J. Lydeck near Craig, Nebr. The windbreaks are multiple rows of mixed deciduous and coniferous species. They are over 25 years old, and their positive influence has been proved by the regular yearly yields on the protected areas. During the drought of 1934, without irrigation, Mr. Lydeck's potatoes yielded 250 bushels and his corn 40 bushels per acre, while on all sides, for many miles, crops were burned up by the hot winds which daily swept the area. In the drought of 1936 Mr. Lydeck's oats produced 25 bushels per acre in these protected areas, while his neighbors harvested but 5 bushels on the wind-swept prairie. His orchard likewise was loaded with fruit of excellent quality. Even in normal years the crops from the fields protected by his excellent windbreaks nearly double those on the unsheltered areas.

In the Great Plains we sometimes hear this remark: "I don't want any windbreaks. I don't have any room for trees; they take up too much ground from my crops. They sap the soil of food and moisture and I can't plant my crops out to the fence line." Such statements are not confined to our dirt farmers, but now and then come from farm leaders whose function it is to educate and direct agricultural thinking.

Mr. Lydeck has devoted many acres of his farm to windbreak plantings. He has had protection from the wind and his yields have been consistent and uniform year after year. The windbreaks have increased the value of his farm: It would sell for perhaps double the price of any other farm within miles. But it is not for sale. It is a profitable farm, and the home of a contented family.

Recently James Kring, forester of the Ralston project, reported on a corn field near David City, Nebr., which was protected from the hot, dry, south wind by a windbreak. Four acres were selected for measurement and the area divided into four plots. One hundred feet of corn row was measured off in each plot. The recorded yields are as follows:

Plot No. 1 was protected from the south by a windbreak of trees, and produced 32 pounds of corn per hundred feet of row (about 55 bushels per acre).

Plot No. 2 was located 300 feet north of plot No. 1, and produced 14 pounds per hundred feet (about 25 bushels per acre).

Plot No. 3 was 600 feet north of plot No. 1, and produced 9 pounds of corn (about 16 bushels per acre).

Plot No. 4 was 2,000 feet from No. 1, was out of range of any protection from the windbreak, and produced only 4 pounds of corn (about 7 bushels per acre).

Establishment of Windbreaks

In the Great Plains the proper methods for establishing windbreaks differ somewhat from those followed in other areas. The hot, dry winds, together with the limited moisture, exert a definite influence on small trees just as on other plants, with the possible exception that, with good nursery stock and proper site preparation and care for the first few years, trees can be established when other crops fail. The loss of trees in windbreak plantings in the Great Plains has been due largely to improper site preparation, poor care, inferior nursery stock, and grasshopper damage. The adverse climatic factors can be overcome; trees will grow and even flourish if given the necessary care and attention.

Preliminary Steps

Success in establishing a windbreak stand cannot be expected if the seedlings are merely planted without preparation of the soil and then abandoned. All sites should be either completely plowed or, if this is impossible, two or three furrows should be plowed and the trees set in the prepared strip. From three to five cultivations a year should be given the plants, and this should continue until it is impossible to pass through the trees.

Windbreaks can be planted either on the contour or in straight lines. Except in those areas which are level and sandy, the windbreaks should be laid out on the contour—this for reasons other than protection. A contour planting establishes a permanent guide line to be followed in farm operations which is better for the conservation of soil and water than straight lines up and down slopes, even though the grade is very slight. In the wheat belt where the land is practically level there may be certain advantages in planting along the section lines.

Composition

Formerly a windbreak meant one row of trees, but that conception has changed in recent years; we now think of a windbreak as consisting of more than a single row of plants. The composition and width are important factors. To be most effective, deciduous trees, evergreen trees, and shrubs are essential. Windbreaks

Cultivating young honey locust and Chinese elm trees in a woodland and windbreak planting. It is desirable in such a planting to keep out weeds and obnoxious plants.

composed of any one of the groups will be effective to a degree and have a place in certain types of protection. It has been demonstrated that one row of shrubs planted at close intervals is effective in nursery practice, and that one row of trees will give some protection to crops. But to build good windbreaks—taking into consideration the ecological factors of tree growth—a combination of all three groups is to be preferred.

The number of rows to be planted must be decided by the farmer and his decision should be based upon several factors, namely, the size of the farm, type of farming, areas to be protected, kinds of crops, number of livestock and other local conditions. From an ecological standpoint, the multiple-row windbreak, varying from 10 to 20 rows of trees and shrubs, is preferred because such plantations simulate a natural forest with an accumulation of ground litter—better soil moisture conditions. In the snow country, the wider windbreaks also collect snow and thus additional moisture is made available to the trees. Beneficial results are secured, however, from one row of plants up to the maximum number practicable to the particular location.

Spacing

The proper spacing of the plants is a subject so controversial, due to the many variations of soil, rainfall, wind velocity, object of planting and other local conditions, that specific recommendations are almost impossible. There should be some variation according to the species used, although the earlier windbreaks were not planted with this in mind. Practically all the multiple plantings were approximately 4 feet by 4 feet. Hedges of Osage orange were spaced 1 foot apart in a single row bordering a field, and many miles of these hedges are still alive and thrifty.

In other parts of the Great Plains, plantings have been variously spaced—from 2 by 4 up to 18 by 20 feet. It is my opinion that a spacing that is too wide is as bad as one that is too close. The close spacing injures and kills out the trees, while the wider spacing doesn't produce a windbreak of any value over a long period. It seems logical that a modified spacing between the two extremes, together with proper silvicultural management, gives the quickest and most effective results. Where close planting is practiced, thinning should be done at the proper time. The whole aim in developing a windbreak is to keep a solid bank of foliage from the ground to the top and therefore the side branches must not be allowed to die. As soon as the branches touch, the thinning should be done. This is particularly applicable to conifers but much less so to deciduous trees.

Since it is essential that the plantings be cultivated, the spacing should be regulated according to the kind of cultivating implements available. To develop a multiple row shelterbelt, three groups of plants are desirable: First, the outer group, consisting of one to three rows of close-growing shrubs which hold their foliage to the ground and form a dense wall; second, the intermediate group, or medium-sized plants adjacent to the shrubs; third, the group of taller trees, which are placed next to the medium-sized group, and which will determine the height and therefore the scope of its effective influence. If this arrangement is used on both sides, a high center, sloping both ways, will be the result.

From my observation of plantings the following general rule for spacings may be considered satisfactory: Rows 7 to 10 feet apart, and the plants in the row 4 to 8 feet apart. In most windbreaks the rows may be a uniform distance apart. The outer border of shrubs can be spaced 4 to 6 feet in the row (some foresters advocate planting caragana 1 foot apart on the

(*Continued on p. 254*)

Humus and Soil Conservation

By Selman A. Waksman [1]

AMONG the various factors which markedly influence the conservation of the fertility of our soils as well as of the very soils themselves, none is more important than the abundance and nature of the soil organic matter or the soil humus. Its presence is very characteristic of the soil and distinguishes it from a mass of disintegrated rock material. Humus serves a most important role in soil formation, in the process of weathering, and gives the characteristic nature to the soil profile. It improves the physical condition of the soil, by increasing its moisture-holding capacity, by favoring better aeration, and by creating a better soil structure. It improves the chemical condition of the soil, by serving as a storehouse of plant nutrients and by rendering some of the inorganic elements more readily available to the plant, thus making the soil more fertile; it improves the buffering capacity of the soil, or its ability to avoid rapid changes in reaction to acidity and alkalinity; it also serves to neutralize toxic conditions of the soil as a result of extensive cultivation or use of excessive amounts of artificial fertilizers. It improves the soil as a medium for the growth of micro-organisms, which bring about numerous processes highly important for plant nutrition. Finally, it makes the soil a better substrate for the growth of our cultivated and uncultivated crops. In general, humus exerts a most controlling effect upon the soil and its fertility; without humus, the surface layer of the earth could hardly be designated as a soil in a true sense. The conservation of the soil humus may, therefore, truly be considered as of the greatest importance for soil fertility and crop production.

Although so highly significant in the soil and in soil processes, humus constitutes, in the majority of soils, only a small fraction of the total body of the soil. The actual amount of humus found in any soil depends upon soil type, land topography, vegetation, and treatment. It varies from about 0.5 percent or even less, for the very poor sandy soils, to 5, 6, and even 12 percent in the case of the prairie soils. The humus content may be even higher in soils formed from peat bogs. The humus is usually concentrated in the upper soil layer or horizon and diminishes rapidly in the subsoil (fig. 1).

The term "humus" is used to designate all organic matter found in the soil, as well as that organic matter

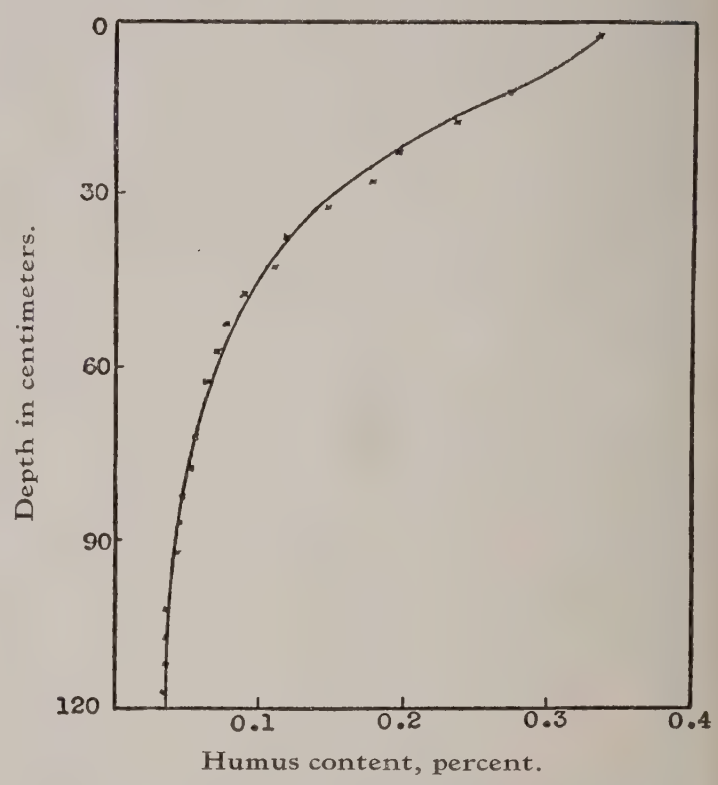


Figure 1.—*Humus distribution with depth of a Carrington silt loam, Nebraska (after Russell and Engle).*

which is produced, through the agency of microbes, in the decomposition of plant and animal wastes in soils, in composts and in the disposal of sewage and garbage. Plants and plant residues form the all-important sources of humus, either directly, as in the case of roots, stubble, leaves, composts and green manures, or indirectly, after the plant products have become digested by the animals and have become partly converted into animal substance, which in itself will sooner or later become a source of humus. Straw or leaves, horse manure or cow manure, earthworms or beetles are not yet humus; however, after they have become partly digested by the numerous soil inhabiting microbes, they are gradually converted into a dark-colored, amorphous mass, which is humus.

In order to determine the chemical nature of humus and recognize the processes which lead to its formation, it is necessary first of all to know the chemical composition of the plant materials from which it is formed. These materials, whether left as residues from cultivated and uncultivated crops, or grown specially as sources of humus in the form of green manures, are not uniform in chemical composition. They comprise a number of compounds, which are decomposed by the soil microbes with different degrees of rapidity.

[1] Microbiologist, N. J. Agricultural Experiment Station, New Brunswick, N. J

Figure 2.—*Chart illustrating the formation of humus from different source materials. (Original prepared by Waksman and Starkey.)*

Among these compounds, one may mention a variety of carbohydrates, ranging from sugars and starches to cellulose, the latter being the fibrous material which is so characteristic of cotton, straw, and wood; of proteins and their derivatives or the nitrogen bearing contituents of the plants; of various fats, waxes, and resinous bodies; of lignins, or compounds which cause the stiffness or woodiness of the woody portion of the plants; of mineral elements and salts, some of which are soluble in water and others insoluble; finally, of a variety of chemical compounds, which vary in nature and in abundance, depending upon the kind of plant, its age and conditions of growth.

When placed in the soil or in a compost, the plant residues are attacked immediately by a great variety of bacteria, molds, worms, insects and other microscopic forms of life inhabiting the soil or the compost. The various chemical constituents of the plant are not decomposed alike by the different organisms. Some compounds, as in the case of the sugars, starches, and certain proteins, are decomposed very rapidly; others, as the celluloses, fats, and different nitrogenous bodies are attacked more slowly; still others, like the lignins, waxes, and resins, are highly resistant to decomposition. The micro-organisms themselves are highly specialized in their choice of nutrients: some prefer to decompose certain chemical compounds and some are able to attack others; certain organisms develop first on the

53197——38—2

Table 1.—*Chemical composition of rye plant at different stages of growth*

[Percent basis of dry material]

Stage of plant growth [1]	Cold water soluble constituents			Cellular carbohydrates	Lignin	Total nitrogen	Total minerals
	Total soluble	Soluble carbohydrates	Minerals				
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
I. 10–14 inches high	34.2	3.5	5.1	34.7	9.1	2.50	7.7
II. Just before heads begin to form	22.7	6.0	4.6	48.2	11.8	1.86	5.9
III. Just before bloom	18.2	2.8	2.4	53.3	18.0	1.01	4.9
IV. Mature plants	9.9	2.1	2.1	59.2	19.8	.24	3.9

[1] In the case of III and IV, only stems and leaves were used.

fresh residues, while others follow; some grow under certain soil conditions, as influenced by reaction, temperature, aeration, water supply, etc., while other organisms develop under other conditions. As a result of the influence of these various factors, namely the nature of the plant residues, the nature of the microorganisms and the conditions of decomposition, the resulting humus will vary considerably in abundance and in chemical composition.

The processes of decomposition of the complex plant constituents are frequently designated as "decay," "mineralization," "humification;" they do not result in the complete destruction of these compounds, but lead to the formation of various volatile and nonvolatile products. These include carbon dioxide, ammonia, phosphates, sulphates, and others; the ammonia is rapidly oxidized by certain organisms to nitrate. The various microbes bringing about the decomposition of the plant residues will build up a considerable amount of cell substance as a result of their extensive multiplication. The synthesized material consisting of proteins, carbohydrates, fats, etc., may amount to as much as 10 to 30 percent of the decomposed residues. The new compounds together with the resistant undecomposed portions of the plant and animal residues form the major part of the humus in soils and in composts.

Humus Formation at Different Stages

In order to illustrate the above processes, it is sufficient to cite certain experiments, carried out at the New Jersey station, on the formation of humus in the decomposition of rye plants, harvested at different stages of growth. Table 1 shows the chemical composition of these plants, table 2 the rapidity of their decomposition, as measured by carbon dioxide evolution, and table 3 the amount and nature of humus produced from young and mature plant material. When the plants are young they are rich in water soluble minerals, in soluble carbohydrates and in nitrogenous substances. As they grow older, these diminish, while the cellular substances, especially the fibrous materials and the lignins or woody bodies, increase.

The changes in the chemical composition of the growing plant have an important influence upon the rate of their decomposition and upon the products formed. The younger the plant, the more rapidly it decomposes and the less humus is formed. Among the different products of decomposition, none is more

Table 2.—*Decomposition of rye plants at different stages of growth* [1]

[2 grams of dry material added to soil]

Stage of plant growth	Carbon dioxide given off	Nitrogen liberated or consumed
	Milligrams	*Milligrams* [2]
I	286.8	+22.2
II	280.4	+3.0
III	199.5	−7.5
IV	187.9	−8.9

[1] Period of decomposition 27 days.

[2] + indicates that nitrogen was liberated as ammonia, which was then oxidized to nitrate. − indicates that nitrogen was required in order that the organisms could decompose these materials; without added nitrogen, the rate of decomposition, as measured by evolution of carbon dioxide, would have been even slower.

Table 3.—*Humus formation from young rye plants and from mature rye straw*

Stage of plant growth	Days of decomposition	Total organic matter left	Total cellular carbohydrates left	Lignin left	Protein left
		Percent	*Percent*	*Percent*	*Percent*
Young plants (second stage)	30	27.0	21.0	63.6	31.0
Mature plants (fourth stage)	60	58	41.8	88.7	[1] 286.7

[1] The increase in protein is due to its being built up by the micro-organisms decomposing the straw; this accounts for the nitrogen consumption reported in table 2.

Table 4.—*Influence of fertilization upon the humus content of the soil*

Soil treatment	Humus content	Nitrogen content
	Percent	*Percent*
No manure since 1843	1.50	0.10
Stable manure since 1852	4.92	.26
Complete artificial fertilizers (ammonium sulphate)	1.69	.10
Complete artificial fertilizer plus stable manure	5.38	.25
Potash and phosphate only, no nitrogen	1.65	.09

important than the nitrogen. The decomposition of the younger plants results in the liberation of some of the nitrogen as ammonia. In this experiment, 44 percent of the nitrogen was liberated in 27 days from the youngest plants. On the other hand, in the decomposition of mature plants, no nitrogen was set free; actually rapid decomposition of the plant and its transformation into humus required additional inorganic nitrogen. This is a practice usually employed in the preparation of composts from straw. There is a certain stage in the growth of the plant, namely when it contains about 1.5 percent to 1.7 percent nitrogen, when the plant material decomposes readily, without liberating nitrogen and without requiring any added nitrogen. After some period of time, the humus itself will gradually decompose and the nitrogen will become slowly liberated.

The results reported in table 3 show definitely how the amount of humus left depends upon the age and nature of the plant. The young rye plants, after 30 days decomposition, left only 27 percent of the organic matter as humus. The mature plants, however, even after 60 days of decomposition, left more than double that amount of humus. In the case of the young plants, only a third of the nitrogen was left in the humus and two-thirds were made available, while in the mature plants, the humus contained three times as much nitrogen as the plant itself. This nitrogen was obtained from added mineral sources.

Sources of Humus

The amount of humus formed in the decomposition of plant materials is thus shown to depend, primarily, upon the chemical composition of these materials. Vague generalizations are usually made concerning the amount of humus left in the soil as a result of the addition of different plant and animal substances which serve as sources of humus. In order to place this information in as comparative a manner as possible, especially for the purpose of illustrating the relation between decomposition and humus formation, a special chart is presented here (fig. 2).

This chart shows that the various sources of humus can be divided into several overlapping groups: 1. Some materials, like green plants and animal residues, decompose rapidly, leaving comparatively little humus; this is accompanied by a rapid liberation of the nitrogen and of the mineral elements in available forms. 2. Other materials like peats, which have already undergone extensive decomposition, are largely in a humus state and decompose only very slowly; however, the indiscriminate use of these sources of humus, except for very special conditions such as lawns and nursery beds cannot be recommended without certain modifications. 3. Animal manures and composts of plant residues form ideal sources of humus, since they gradually decompose, liberating some of the nutrients in a form available for plant growth and leaving considerable humus in the soil. 4. Mature plant materials, such as straw, leaves of trees and needles, decompose and form humus very slowly. No nitrogen is liberated before a considerable period of time has elapsed. The addition of nitrogen to soil may be required for the rapid decomposition of these materials; otherwise, the micro-organisms will compete with the growing plants for the nitrogen needed by them in the decomposition of these nitrogen-poor materials.

Humus and Soil Conservation

The gradual deterioration of the soil, as a result of cultivation or as a result of wind and water erosion, is always associated with losses of organic matter. These losses can serve as direct measures of the losses in soil fertility. Before the introduction of artificial fertilizers and before the systematic utilization of legumes in crop rotations, man depended entirely upon reserves of soil humus for his crop nutrients. These were made available through the slow and gradual decomposition of the humus by the countless micro-organisms inhabiting the soil. However, too often even now man still depends upon these reserves for the major portion of the nutrient requirements of his crops. Humus has been provided by nature to serve as the ever-normal granary for mankind upon which he can draw for his countless crops. One cannot afford, therefore, to continue to use up the humus without definite provision for its replacement.

It has been calculated, for example, that as a result of cultivation over a period of 60 years, soils in a non-eroded condition lost one-third of their total fertility, the losses being much greater during the earlier than the later periods. In the case of dry land farming, the losses may be even greater. It has further been calculated that virgin soil taken under cultivation lost in a period of 50 years as much organic matter as had been accumulated during the previous 5,000 years. When erosion also becomes a factor the losses in organic matter become even greater, since the humus is largely concentrated in the upper layers of the soil, as shown in figure 1. These layers are the ones to be removed by wind or water. Drifts and dust were found to contain much more humus than the residual soil.

It is now generally recognized that in order to prevent soil deterioration by water and wind erosion, the

ntroduction of organic matter is particularly necessary. Soil conservation, from a broad point of view, thus includes the conservation of the organic matter of the soil or the introduction of fresh supplies into the soil where the supply has become depleted. This may be brought about by putting large areas of land under grass, by plowing under special crops in the form of green manures and crop residues, and by the actual introduction of organic matter in the form of stable manures, artificial composts, or peats. The particular method employed must be determined on the basis of local conditions, nature and value of crops, and other factors.

It was concluded, on the basis of numerous experiments carried out in this country and abroad, that continuous cropping even under good management and fertilizer treatment tends toward a depletion of the organic matter of the soil. With heavy applications of farm manure the content of organic matter may be gradually increased over a period of years. When compared with corresponding soils not cropped and fertilized, soils continuously cropped, even if fertilized, showed a gradual loss of organic matter. It is sufficient to cite one of the classical experiments carried out at the Rothamsted and Woburn Experimental Stations in England (table 4).

In addition to stable manures and composts, the proper use of green manures, including cover crops, is capable of maintaining the soil organic matter and the soil nitrogen and of improving the physical condition of the soil, enhancing its water-holding capacity, and preventing excessive erosion. Green manures are utilized for four distinct purposes: (*a*) The conservation of the plant nutrients, (*b*) rendering the nitrogen available for the next crop, (*c*) addition of organic matter to the soil, and (*d*) increasing the supply of nitrogen in the soil through nitrogen fixation.

In summarizing the importance of humus in the soil, it is sufficient to point out its four major functions, namely, (1) in soil weathering, or the formation of a soil from the inorganic rock fractions; (2) in soil fertility, acting as a storehouse of nutrients for plant growth; (3) in improving the physical, chemical and biological soil conditions, thus making the soil a favorable medium for the growth of plants and microorganisms; (4) finally, in soil conservation, through improvement of the water-holding capacity, base-exchange capacity, nutrient-holding capacity, and other properties of the soil.

The humus of the soil fully deserves, therefore, to replace the time-worn expression "the fat of the land," since it is synonymous with it.

WINDBREAKS HELP CONTROL

(*Continued from p. 249*)

outside row) depending upon the species used, while the larger-growing trees should be spaced 6 to 8 feet in rows. Silvicultural management is essential even with this spacing, and thinning should be taken care of when trees crowd.

A combination windbreak and post lot planting should prove valuable as such a planting would produce a crop of fence posts at thinning time. By carefully planning the composition, black locust or catalpa might be a part of the original planting. It could be so spaced that at the time of thinning the post trees could be removed without lessening the effectiveness of the windbreak.

Species

The relative position of any species depends on the type of windbreak planned. Where three or four rows of plants are used to develop a low shelter, the largest plants may be chosen from those used in the outer rows of a tall windbreak. Or, where desired, the so-called intermediate trees may be the tallest in the group.

The variation in growth in a species in different localities may also change its position in the windbreak. The Osage orange is generally considered a medium-sized tree—this because the close planting which is practiced has checked its development. In most plantings the Osage is located rather close to the border of the windbreak. Many trees can be found that will reach the height of ash and cottonwood and a girth of 32 inches, and these could well occupy the tallest section of any windbreak. Variation in growth is also true of the Chinese elm. The Russian olive is another species which is generally considered a medium-sized tree and is used in borders.

The American elm and the Russian olive may occupy different positions in different windbreaks, their positions based on local conditions. But here again, it is not difficult to find trees that will grow as tall as the American elm and develop a girth of 36 inches.

Therefore, since a given position in a windbreak is relative and depends on local conditions, it is impossible to make definite recommendations for the placing of species until the type of windbreak desired is thoroughly understood along with the soil, climate and rainfall of the location.

The species suitable for plantings vary somewhat in the different latitudes and are rather limited. Trees valuable for windbreaks—their positions depending on

(*Continued on p. 257*)

Wind intensifiers made of boards and galvanized iron and placed on top of dunes. Foreground, badly eroded area; a dune 26 feet high, in background.

Research Contributions to Wind Erosion Control

By H. H. Finnell [1]

AT THE outset of wind-erosion control work in the southern plains in 1934 a thorough canvass of published and unpublished experimental data of the local experiment stations was made. Very few, if any, studies had been conducted directly on the subject of wind action, its fundamental causes and its effects upon the soil. It was generally observed that wind erosion occurred more frequently after long droughts and that active erosion was apparent after heavy rains when but a paper-thin crust of the surface soil had dried. Nevertheless, in the various stations many useful facts bearing indirectly upon and contributing to the planning of a preventive program were revealed as well as certain indicative leads which proved quite useful.

The information that proved most significant may be summarized as follows:

Ridged, cloddy, or trashy surface exposures resisted wind action. Certain kinds of plant residues were more effective than others and endured longer. The effects of tillage without trash were relatively temporary. Erosion became very difficult to control after two or more seasons of crop failure. Much evidence showed that rotations were not dependable through the hazards of erratic seasonal conditions, although there was a very meager evidence of possibilities for increasing the dependability of crops by manipulation of sequence. Even on the best wheat lands sorghums for grain or forage production exhibited a higher degree of dependability than wheat or other small grains. Studies of relations of various factors, particularly initial moisture and soil conditions, to crop production were in progress. The first results of run-off water conservation upon the amount and regularity of production of adapted crops were being observed. Preliminary observations of the semiarid soil nitrogen cycle and factors governing it were available. Studies of moisture relations and the disposition of rainfall as applied to a few specific soils and slopes were available. Climatological data over periods of from 20 to 60 years, but from widely scattered points, were available for most of the area.

In 1933 and 1934 the consequences of prolonged drought became acute over sections of the area and it was apparent that emergency tillage was no longer adequate for the control of wind erosion. At the same time all evidence plainly indicated the prime importance of growing vegetation and wind-resistant residue as reliable safeguards. Thus it was that vegetation became the basis of the permanent program of demonstration projects of Region 6. Almost all the methods applied since the inception of the program have had as their direct or indirect objective the obtaining and utilizing of vegetation for erosion prevention. The application of control methods to various problem areas is guided by consideration of (1) efficient land use, (2) efficient water use, (3) adequate safeguards against soil wastage.

A pointed example of handling a complex requirement may be observed in the conservation program developed for problem area 2B, the southern plains

[1] Regional Conservator, Soil Conservation Service, Amarillo, Tex.

heavy wheatlands. The interdependence of the methods applied as relative to the objectives sought is interesting, and from a practical standpoint is conducive to a self-sustaining program. On the deep heavy soils of this problem area the infiltration rate is slow, and in spite of the gentle slopes considerable waste of surface waters was experienced during rains of high intensity. Research has revealed valuable possibilities of improving the efficiency of moisture utilization by means of contour tillage and terracing with results pointing to increase both in amount and dependability of production. The application of this information not only profitably develops a hitherto neglected resource, but contributes directly to the amount of ground cover and the regularity of its renewal.

A further contribution to the continuity of cropping, which is highly important in maintaining an adequate surface trash supply for erosion prevention, has been made by experimental studies of rotations and cropping systems. The useful information on this subject is both negative and positive. Systematic rotations were found inadequate to maintain an even flow of production or to improve soil fertility under semiarid plains conditions. At the same time, studies of the factors governing wheat production provided a basis of foreseeing production possibilities with sufficient accuracy to permit the practical planning of a variable cropping program to serve the purpose of and take the place of the unworkable systematic rotation. This variable cropping plan requires the introduction of sorghum crops, thus serving a double purpose—the utilization of current moisture and fertility resources which normally go to waste under a system of straight wheat farming, and the filling of intervals unfavorable to wheat production during which the land would otherwise be devoid of protective cover.

General experience and observation have emphazised the necessity of regularly returning a large amount of erosion-resistant crop residue to the land as a safeguard against wind-erosion hazards, but research has pointed out a further utilization of this material to maintain a high state of fertility. Soil and seasonal conditions unfavorable to legume crops, but favorable to free living organisms for the fixation of atmospheric nitrogen, necessitate dependence upon the latter for the maintenance of the nitrogen cycle. A high lime content, a plentiful supply of highly available phosphorous, and a normal freedom of the soil from leaching losses provide the natural conditions for an adequate nitrogen income with but one addition necessary on the part of soil management. A wide nitrogen-carbon ratio is essential to stimulate fixation, and this can be regularly provided by the gradual working into the soil of the carbonaceous residue left from such erosion-resistant crops as small grains and sorghums. Crop residues saved from grazing and from burning serve first to protect the surface from exposure to wind erosion, and finally to provide the wide nitrogen-carbon ratio essential to adequate nitrogen income.

The low rainfall efficiently utilized is a positive advantage to easy fertility maintenance, but skilled crop management to avoid lengthy periods of idleness are essential. It is important, in order to achieve the highest degree of soil conservation and economic stability, that soil moisture accumulations be used before they penetrate beyond the root zone.

The present ill repute of this area is not fundamentally due to the long drought period or to other unfavorable natural conditions. It could be more justly charged to the extremely low efficiency of the water-utilization and crop-management methods practiced. The natural conditions are favorable to a permanent agriculture. The corrections most needed are not so much changes in land use as changes in farming methods.

In the several other problem areas of Region 6 many different problem complexes present themselves. However, none of the needs can be successfully dealt with until the leaders of agriculture begin to observe the specific pertinent facts of the region and bend their efforts to work with rather than against natural conditions. To observe more adequately the physical, chemical, and economic facts, and to apply them to a thoroughgoing improvement of plains agriculture, much new research needs to be undertaken in the various areas.

When the available known methods of erosion control are applied to each problem area on the basis of efficient land and water utilization, either a different list of methods results for each problem area, or a different relative importance of various methods is developed. This may be illustrated by comparing the outline of the conservation program in three adjacent farming areas of the region.

Problem area 2B, taking in the southern plains deep heavy wheatland soils, requires the following: (1) Water conservation by contour tillage supported by terracing solely for water conservation purposes to promote vegetative cover; (2) crop diversification with wheat, the major crop, and sorghum feed crops, the minor crop, in variable rotation guided by seasonal and soil conditions to maintain vegetation; (3) the conservation and gradual return of carbonaceous residues to the soil to prevent wind erosion and stimulate

Typical blown-out wheatfield resulting from loss of residue and from improper land use during the drought period. Portions of this field have been blown out to the subsoil, and sand drifts have formed in other areas.

nitrogen fixation; (4) marketing of small grains, and the utilization of feed grains and forages through small permanent or transient livestock units—depending upon availability of grazing-type land in the neighborhood—to stabilize the business; (5) feed storage facilities and the maintenance of a 2-year feed reserve to facilitate the conservative grazing of growing crops, stalk fields, and permanent pastures.

Problem area 3C, having medium-textured rolling plains soils, requires: (1) Contour tillage and terracing for the dual purpose of water-erosion prevention and water conservation to promote the continuity of vegetative cover; (2) the strip crop rotation of cotton to distribute effectively the vegetative cover, feed crops, and soil-building crops; (3) the conservation of fibrous carbonaceous residues for wind-erosion prevention and for fertility maintenance; (4) feed-storage facilities; the marketing of cotton and the utilization of feed grains and forages through small permanent livestock units; (5) the maintenance of 1-year feed reserve to facilitate the conservative management of grazing, stalk fields, growing crops, and pastures.

Problem area 5A, with medium-depth high-plains soils, requires the consistent use of erosion-resistant crops, either in solid planting or in strip planting if economic preferability demands the use of erosion non-resistant crop types; the regular return of crop residues to the soil, and the strict control of stalk field grazing.

It will be noted that surface-water control measures serve a single purpose in one instance, a dual purpose in another, and are not required at all in the third. Similarly, systematic rotation is used in one instance, variable rotation in another and continuous cropping in a third. Strip cropping is used occasionally in one area, regularly in another, and optionally in the third. The water management requirements also vary among the different grazing areas in similar fashion to that prevailing in the crop land areas.

In this manner the findings of research, interpreted through a clear understanding of the conservation objectives, are applied separately to the sixteen or more individual problem areas of the region.

WINDBREAKS HELP CONTROL

(Continued from p. 254)

conditions—are cottonwood, American elm, ash, hackberry, locust, oak, Chinese elm, Osage orange, mulberry, Russian olive; and, for the border plantings, wild plum, chokecherry, lilac, tamarix and caragana. Among the evergreens the red cedar, western white spruce (Black Hills) and Colorado spruce, Austrian and western yellow pine are most valuable.

Conifers are effective for both winter and summer protection, but they are more difficult to establish than deciduous trees. A combination of the two is preferable, and such plantings produce the most satisfactory results.

Above: When Sudan or other grain sorghums are harvested, enough stubble is left to afford protection during the blowing season.

Left: This farmer has his field back under complete control. He is shown turning under the wheat stubble to provide protection during the next blowing season. He can continue in wheat production so long as conditions are favorable.

Below: The first step, leveling hummocks sufficiently to make cultivation possible. This farmer is doing the job by dragging heavy railroad irons behind a tractor.

Recent Publications for Study by Soil Conservation Workers

For REFERENCE

Compiled by Mrs. ETTA G. ROGERS, Publications Unit

Field offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

Soil Conservation Service

Advance Report on the Sedimentation Survey of Black Canyon Reservoir, Emmett, Idaho. May 21 to August 13, 1936. mm. SCS-SS-19. December 1937.

Soil and Water Conservation Investigations.[1] Progress Report, 1931-36, Arkansas-Louisiana-East Texas Sandy Lands Soil and Water Conservation Experiment Station, Tyler, Tex., in cooperation with the Texas Agricultural Experiment Station, College Station, Tex. mm. SCS-ESR-4. January 1938.

Office of Information U. S. Department of Agriculture

An Economic Study of Cattle Business on a Southwestern Semidesert Range. Circular 448. Forest Service. December 1937.

Drainage of Irrigated Farms. Farmers' Bulletin 805. Bureau of Agricultural Engineering. Slightly Revised December 1937.

Indicators of Southwestern Range Conditions. Farmers' Bulletin 1782. Forest Service. December 1937.

Nitrogen-Fixing Bacteria and Legumes. Farmers' Bulletin 1784. Bureau of Plant Industry. December 1937.

Wildlife Conservation Through Erosion Control in the Piedmont. Farmers' Bulletin 1788. Soil Conservation Service. November 1937.

Implements and Methods of Tillage to Control Soil Blowing on the Northern Great Plains. Farmers' Bulletin 1797. Bureau of Plant Industry (prepared in collaboration with the Soil Conservation Service). January 1938.

Spreading Water for Storage Underground. Technical Bulletin 578. Bureau of Agricultural Engineering. December 1937.

Chemical and Physical Studies of Certain Hawaiian Soil Profiles. Technical Bulletin 584. Bureau of Chemistry and Soils. December 1937.

Effect of Fertilizers on Composition of Soybean Hay and Seed and of Crop Management on Carbon, Nitrogen, and Reaction of Norfolk Sand. Technical Bulletin 586. Bureau of Plant Industry. December 1937.

The Chemical Composition of Soils and Colloids of the Norfolk and Related Soil Series. Technical Bulletin 594. Bureau of Chemistry and Soils. January 1938.

Agricultural Experiment Stations

Agricultural Outlook for Illinois, 1938. Circular 480. Agricultural Experiment Station, Urbana, Ill. December 1, 1937.

Annual Bluegrass (Poa annua L.), and Its Requirements for Growth. Bulletin 630. Agricultural Experiment Station, New Brunswick, N. J. September 1937.

Annual Cover Crops for Michigan Orchards. Circular Bulletin 163. Agricultural Experiment Station, East Lansing, Mich. October 1937.

Baffles for Terrace Outlet Control. Circular 328. General Series 103. Oklahoma Agricultural and Mechanical College, Stillwater, Okla. Reprint, 1937.

Colloidal Properties of Soil Organic Matter. Research Bulletin 267. Agricultural Experiment Station, Columbia, Mo. October 1937.

Composition of Corn Fodder Grown in Drouth Years. Bulletin 390. Agricultural Experiment Station, Columbia, Mo. October 1937.

Conservation of Montana's Irrigated Lands. Bulletin 350. Agricultural Experiment Station, Bozeman, Mont. December 1937.

County Agricultural Planning: North Dakota. Circular 159. Extension Service, North Dakota Agricultural College, Fargo, N. Dak. November 1937.

Design of Agronomic Experiments for Plots Differentiated in Fertility by Past Treatments. Research Bulletin 226. Agricultural Experiment Station, Ames, Iowa. November 1937.

Experiments with Hay Crops in Alabama. Circular 79. Agricultural Experiment Station, Auburn, Ala. October 1937.

Forest Restoration in Missouri. Bulletin 392. Agricultural Experiment Station, Columbia, Mo. November 1937.

High-Altitude Studies on Dry-Land Grasses and Clovers. Bulletin 439. Agricultural Experiment Station, Fort Collins, Colo. November 1937.

Land Classification in West Virginia based on Use and Agricultural Value. Bulletin 284. Agricultural Experiment Station, Morgantown, W. Va. November 1937.

New York State 1938 Agricultural Outlook. Cornell Extension Bulletin 382. Cornell University, Ithaca, N. Y. December 1937.

Nutritional Characterisitics of Some Mountain Meadow Hay Plants of Colorado. Technical Bulletin 21. Agricultural Experiment Station, Fort Collins, Colo. October 1937.

A Preliminary Study of the Effect of Cultivation on Certain Chemical and Physical Properties of Some South Dakota Soils. Bulletin 314. Agricultural Experiment Station, Brookings, S. Dak. September 1937.

Save Your Soil by Terracing. Circular 122-A. Extension Service, Colorado State College, Fort Collins, Colo. August 1937.

Save Your Soil: How to Run Contour and Grade Lines. Circular 123-A. Extension Service, Colorado State College, Fort Collins, Colo. August 1937.

Slick Spots in Western Colorado Soils. Technical Bulletin 20. Agricultural Experiment Station, Fort Collins, Colo. October 1937.

Soil Conservation: A Philosopher's Viewpoint. Circular 97. Extension Service, University of Vermont, Burlington, Vt., and U. S. Department of Agriculture cooperating. January 1938.

Soils of Judith Basin County. Bulletin 349. Agricultural Experiment Station, Bozeman, Mont. December 1937.

S-O-S: Save Our Soil! Extension Circular 219. Extension Service, North Carolina State College of Agriculture and Engineering, Raleigh, N. C., in cooperation with the U. S. Department of Agriculture. December 1937.

A Statistical Study of Agricultural and Related Trends in South Carolina. Bulletin 312. Agricultural Experiment Station, Clemson, S. C. October 1937.

A Study of Farm Layout in Indiana. Bulletin 423. Agricultural Experiment Station, Lafayette, Ind. August 1937.

A Study of the Operation of the 1936 Soil Conservation Program in Vermont. Bulletin 413. Agricultural Experiment Station, Burlington, Vt. March 1937.

Truck Crop Investigations: Rapid Chemical Tests for Coastal Plain Soils. Bulletin 95. Virginia Truck Experiment Station, Norfolk, Va. April 1, 1937.

Valuable Plants Native to Texas. Bulletin 551. Agricultural Experiment Station, College Station, Tex. August 1937.

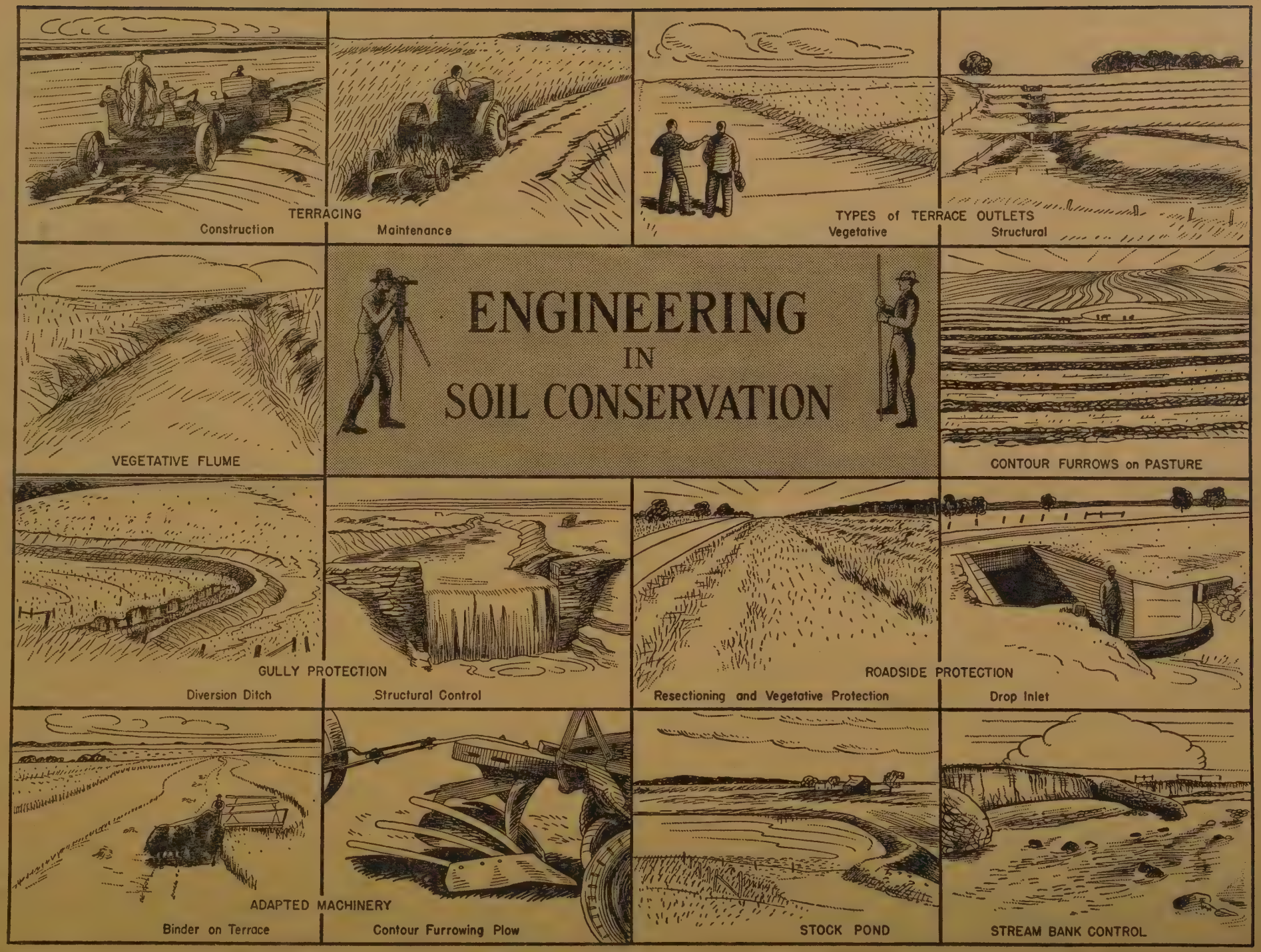
Miscellaneous

Better Land Use: A Program of Action. Bureau of Agricultural Economics, U. S. Department of Agriculture, Washington, D. C. 1937.

Grasses in Kansas. Report of the Kansas State Board of Agriculture for the Quarter Ending December, 1936. Vol. LV, No. 220-A. Kansas State Board of Agriculture, Topeka, Kans. 1937.

Report of the Chief of the Soil Conservation Service, 1937. 10¢ per copy from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

[1] Issued for use by S. C. S. staff and cooperating officials only.


TERRACING
Construction
Maintenance
TYPES of TERRACE OUTLETS
Vegetative
Structural
VEGETATIVE FLUME
ENGINEERING
IN
SOIL CONSERVATION
CONTOUR FURROWS on PASTURE
GULLY PROTECTION
Diversion Ditch
Structural Control
ROADSIDE PROTECTION
Resectioning and Vegetative Protection
Drop Inlet
ADAPTED MACHINERY
Binder on Terrace
Contour Furrowing Plow
STOCK POND
STREAM BANK CONTROL

SOIL CONSERVATION

FFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
NITED STATES DEPARTMENT OF AGRICULTURE · WASHINGTON

1.6
S.35

U. S. F. S. RECEIVED
LIBRARY
MAY 24 1938

May — 1938

Contents

Page

Grass In Action:
By Ivy M. Howard 259

Home-Made Sod Cutters 261

Ecological Relations of Vegetation and Erosion:
By Charles J. Whitfield 262

Some Lespedeza Relationships:
By A. J. Pieters 265

What We Have Learned About Terrace Spacing at Guthrie, Oklahoma:
By A. E. Brandt and G. W. Musgrave 267

Book Reviews and Abstracts:
By Phoebe O'Neall Faris 270

For Reference:
Compiled by Mrs. Etta G. Rogers ..... Opposite 270

Soil Conservation is issued monthly by Soil Conservation Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. Soil Conservation seeks to supply to workers and cooperators of the Department of Agriculture engaged in soil conservation activities, information of especial help to them in the performance of their duties, and is issued to them free by law. Others may obtain copies from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of $1.00 per year, domestic; $1.40 per year, foreign. Postage stamps will not be accepted in payment.

WELLINGTON BRINK
EDITOR

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

VOL. III • NO. 11

H. H. BENNETT
Chief, Soil Conservation Service

MAY • 1938

ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON

The native grasses, especially the big and little bluestems, return to a pasture given protection from fire and overgrazing. In the past this pasture was burned every year and was so badly overgrazed as to be almost entirely unfit for grazing.

Grass In Action

By Ivy M. Howard[1]

SOD-RIPPING plows that turned thousands of acres of Central Great Plains grass land "wrong-side-up" so that wheat could be grown for sale at sky-high World War prices are now growing rusty. The "marginal" lands, no longer profitable in wheat, are being once more planted to soil-saving and moisture-conserving grass.

Throughout Region 7 grass is being used as the Big Bertha in erosion control. Concrete and masonry structures—large, awe-inspiring, expensive masterpieces of engineering skill—have made their bow to the lowly bunches of fibrous-rooted grass. Take Oklahoma for example. In 38 counties where the Soil Conservation Service is cooperating with farmers in

Terrace outlet channel emptying into a good pasture sod, immediately after rainfall of 1 inch in half an hour. The water is spread out and allowed to filter away without erosion or cutting effects.

(Continued on next page)

[1] Section of Information, Soil Conservation Service, Salina, Kans.

A stand of little bluestem acting as a retainer and collector of soil in the windy seasons of blow sand.

demonstrating best methods of soil conservation, 64,000 acres of land once in cultivation has been planted to grass and 5-year cooperative agreements call for the establishment of grass on 43,000 additional acres that are so scarred by serpent-like gullies that they are no longer profitable in clean-tilled crops.

GRASS as a weapon in erosion control has many uses other than that of revegetating fields taken out of cultivation. It is used to sod terrace outlets and outlet channels; it is used for gully control; it is used in buffer strips alternated with strips of clean-tilled crops to check soil losses on sloping fields that still possess much fertility; and it is used on contour pasture ridges and furrows.

In talking of the value of grass-covered furrows on an 80-acre pasture on his 160-acre Jewel County, Kans., farm, Ira L. White says, "Hardly a teacupful of water ran off the pasture when a 2-inch rain fell in June, as a result of the water held on the pasture. I believe its carrying capacity will be at least 30 percent greater than it was last year."

FARMERS throughout the Midwest are in harmony with White in voicing their praise for contour pasture furrows and ridges, which, 3 years ago, were little known and seldom, if every, used.

For sodding contour pasture ridges, controlling gullies, and protecting terrace outlets and outlet channels in the southern part of the region, Bermuda is recognized as a most valuable grass. Bromegrass is widely used in the northern part of the region. But it is in the native grasses that lie the fondest hopes of soil conservationists. The chief reliance is upon bluestems, buffalo, switch, blue grama, Indian, slough—these and a few other grasses that made the old Chisholm Trail practicable for cattlemen.

NATIVE grasses are being encouraged to return to eroding acres by fencing and artificial seeding. Thousands of acres of gullied land and land which has suffered severe sheet erosion in the Central Great Plains region have been fenced to encourage the return of natural vegetation. Observation shows that wherever plant cover is destroyed or the climax type of vegetation thinned a natural process of restoration sets to work as soon as the cause of disturbance is removed.

It has been demonstrated time and again that if land is protected from grazing, fire, and concentration of run-off water, it will soon be covered with soil-holding natural vegetation.

In encouraging the growth of native grasses by protecting them from the forces that have crowded them off the plains, land is not being retired. It is merely being rededicated to the production of crops for which it is well adapted. A gully controlled by natural vegetation may produce profitable timber and wildlife; a steep slope, naturally vegetated, may with exercise of a little caution against overgrazing be made to furnish economic crops of pasture or prairie hay.

Protected natural vegetation provides a cover that ensures permanent stabilization of soil. To hasten the establishment of such cover, however, much work has been done in the Central Great Plains region in the artificial planting of native grasses. Results indicate that this work has not been in vain.

PLANTINGS of native grasses have in the past been limited by the small quantities of seed available. But last year, with improved machinery and methods of harvesting the seed, much larger quantities were gathered. Many pounds of western wheat and various species of grama were harvested for erosion control plantings before seeds of the bluestems had matured. Farmers in scattered areas are finding it profitable to harvest available native grass seed on their lands. The demand for the seed last year was far in excess of the supply.

In addition to planting grass on land retired from cultivation, many farmers are planting contour buffer strips of grass between strips of row crops on cultivated land. The buffer strips check the speed of runoff water from the clean cultivated strips, filter out soil particles being carried away, and cause much of the water to be absorbed. These strips, made variable in width, eliminate point rows.

Buffer strips are used on many farms without terraces. They serve as permanent guide lines for contour farming, and in most cases, afford protection from erosion during periods of torrential rainfall.

In the Central Great Plains region grass has been found useful in connection with practically all recommended soil-conservation practices. It is made to serve as guide lines for contour farming; it is proving ideal for use in field stripping; it is aiding terraces by protecting terrace outlets and outlet channels; it is an excellent permanent cover crop; it is useful in gully control; it is of first importance in the rededication to vegetation of badly eroded lands; it is proving helpful in making poor pastures more erosion-resistant and better feeding places for livestock; it thrives where fire prevention is practiced; and on farm pond dams and spillways it prevents erosion.

Home-Made Sod Cutters

WIDE usage of sodding to control erosion on small critical areas has led to the construction of simple, home-made, labor saving sod cutters in the Ohio Valley.

Fig. 1.

Figure 1 illustrates a device used in the Collierville, Tenn., camp area. Note the cutting fin welded to the point of the plowshare, and the depth gauge bolted to the beam. The moldboard turns the sod over in the conventional manner. C. C. C. enrollees follow with a truck from which planks are dropped along the slice that has been turned. The sod strip is carefully turned back on to the planks which are then loaded crosswise on to the truck, as shown in figure 4. At the sodding site, the planks are lifted to the ground and tipped so that the sod slips into place as in figure 5.

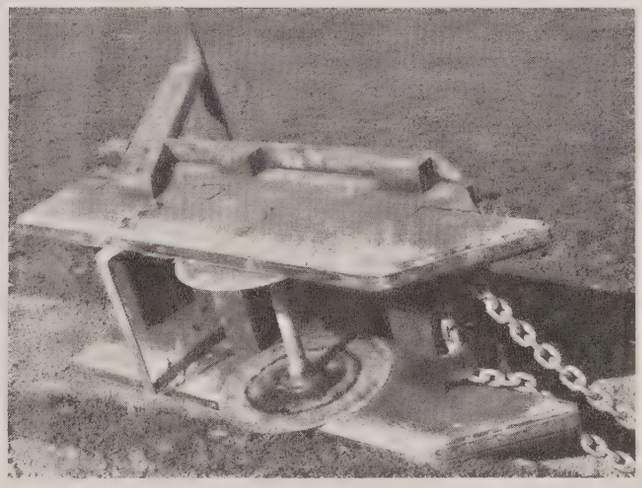


Fig. 2.

Figure 2 shows a conventional sled-type cutter, except that rolling coulters replace the usual side knives. It was built by the Mount Vernon, Ohio, project. The coulters are set to cut 4 inches deep, which is always deeper than the knife in the rear. The knife can be raised or lowered to cut sod of various thicknesses. The coulters make a cleaner cut than side knives, do not tear the sod, and prevent clogging. Experience shows that the rear knife works better if the angle is reduced to about 1½ inches in 8 inches.

To attach the coulter to the axle, it is necessary to remove the collar from the coulter, weld the collar to the axle, and then attach the coulter to the collar. This is to prevent warping of the coulter during the welding process. The pipe axle turns in the oak sled

runners. A hole is bored diagonally in the runner down to the axle for oiling, and a cut-off spike inserted to keep out dirt. The illustration suggests the strength and durability necessarily built into this machine to prevent the runners from pulling together and binding of the coulters.

Figure 3 shows the slightly different type of cutter used in the Washington, Ind., camp area. Rolling coulters divide the sod at the sides; the sharpened and tilted knife just to the rear of them cuts the sod loose underneath. Sod strips are cut in pieces by hand, ready for hauling to the place of use. This type of cutter is particularly useful for taking sod from small patches where the larger cutters cannot be conveniently handled. It can be drawn behind a ½-ton pickup or truck. It has the distinct advantage of being light and easy to handle.

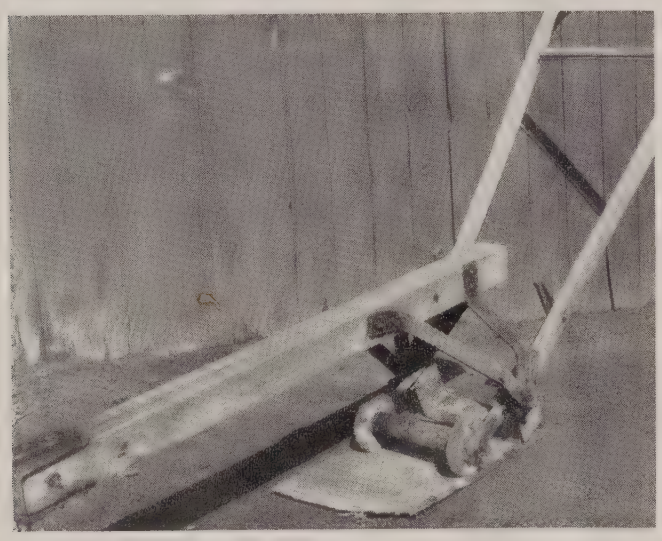


Fig. 3.

Fig. 4.

Fig. 5.

Ecological Relations of Vegetation and Erosion

By Charles J. Whitfield [1]

IT is now widely recognized that vegetation is the most important factor in controlling erosion. Man can maintain, restore, modify, or control the plant cover, but to accomplish this successfully he should thoroughly understand (1) the conditions which determine the appearance and maintenance of different plants and plant types (communities) in different places, and (2) the laws which govern their development and change under the various influences to which they are subjected or exposed. Man is constantly turning natural vegetation to his own uses, as when he cuts the forests for timber or uses the grass lands for grazing purposes. This he has usually done without adequate understanding of the conditions which govern the maintenance or regeneration of the kinds of vegetation he uses, and without sufficient intelligent foresight as to the consequences in the form of tremendous losses from erosion.

Much of the native vegetation has already been exploited. Great damage has been done by cultivation, grazing, lumbering, fire, and the resultant erosion. In most instances Nature has set about to repair these losses; man, in coming to her aid, can work with Nature more effectively if he understands her technique.

Ecology, while often considered as a viewpoint applicable to all biological fields, may also be regarded as a branch of science built on dynamic principles. The ultimate object of plant ecology is to evaluate the different factors of the habitat, and to determine how

[1] Division of Research, Soil Conservation Service, Dalhart, Tex.

far, singly or in combination, they affect the presence or absence, the success or failure, the vigor or weakness, of the various species and communities of plants.

Well thought out, systematic, and carefully controlled experiments on vegetation are needed everywhere if we are to obtain a really thorough knowledge and evaluation of the different factors at work in determining the success of certain types in varied habitats and of certain species in competition with others. It is not at all necessary, in most cases, for the experiments to be elaborate—the simpler the better—and many outstanding problems can be successfully attacked by the simplest means. Basic research is fundamental and oftentimes necessary, however, if corrective measures are to be developed.

Immediate Ecological Values

In any intelligent program a variety of questions arise. Careful and properly directed field work should be based on working plans. The ecological factors and processes at work in each region, and how they appear to influence the vegetation, its composition, growth, reproduction and use, must serve as a guide for such plans. By such means the best methods that can be put to use may be determined, and data may be secured which are practical and comprehensive enough to indicate the trend operation programs should take.

Ecological Concepts

Plant ecology has often been defined as the relation of plants to their environment. There are generally recognized four classes of ecological factors or features of the habitat affecting the vegetation, directly or indirectly, in such a way as to differentiate it from other vegetation. These are climatic, physiographic (topographical), edaphic (soil) and biotic (the effect of animals, including the whole of man's influence on natural vegetation). Ecologically speaking, the term "habitat" has come to mean the sum of any of these factors, so far as they have real effect in determining the existence of one species or one community of plants rather than another. Such processes as grazing, erosion, lumbering, clearing and cultivation, fire, draining and flooding, and construction affect the natural vegetation. Certain ecological concepts, such as succession and the climatic climax, are widely accepted. The application of these principles really makes ecology of value, serving such practical purposes as regeneration of vegetation, erosion control, retardation of flood waters, and conservation of wildlife.

An undisturbed vegetative type, changed by some process such as fire, if left alone over a period of time, tends to undergo a series of changes and will eventually revert back to its original state. Similarly, on bare areas, there are changes in a given definite direction—successive occupation of the area by different groups or communities of plants. This is known as succession, the different plant groups occupying the area at different or overlapping times as plant communities or vegetative types. It is a matter of observation that, while some natural plant communities maintain themselves unchanged for long periods of time, others are more or less transient, changing in character, slowly or rapidly, as the years go by.

Climax Vegetation

Those natural plant communities which undergo no further change, so long as the general conditions of the environment are unaltered, are called climax types. Climax types are generally of broad extent, as the deciduous forest, the grassland vegetation, and the alpine tundra. It has been found that these large climax types are determined by climate. Climate over an area as extended as the United States is diverse; vegetation responds to this diversity and develops according to the particular climate in, first, large groups or types, and, second, minor types within. If left undisturbed, the normal tendency would be for vegetation to develop, by the process of succession, toward the climatic climax. But man has disturbed the vegetation by the processes which have been mentioned. Under man's influence the normal tendency is for the climax types to disappear and the transient or subclimax types to occupy the ground. If vegetation is to be restored, modified or controlled, it is essential to understand that climate determines the great climaxes, while within these the soil and topographic factors become of paramount importance. The value of the climax concept is that it serves as a background or norm against which to project the changes wrought by disturbance of all kinds.

Disturbance Processes

Throughout much of the United States, man has disturbed nearly all the natural vegetation and changed its appearance from its original condition by clearing, cultivation, grazing, fire, lumbering, draining, and construction. The artificial destruction of the climax dominants through the clearing of a forest, the cultivation of the land, overgrazing of the western range, initiate secondary successions or subseres. The degree, extent, and duration of any of these disturbance processes are all factors in methods of conservation, and they find their best measure in the secondary succes-

sions or subseres that are the universal indicators of human influences. It is evident that disturbance is the crucial process against which regulation, control, or prevention must be directed. It can thus be seen that a knowledge of subseres is of great importance because many of the practical problems in erosion control programs can be answered through an intelligent understanding of secondary successions.

In general, the climax dominants tend to come back after a shorter or longer time, provided the conditions have not been too radically changed and there are enough seed parents left in the neighborhood. The problem of finding out how long they take to come back, and what conditions may hasten or retard the process, which is the practical problem if the climax dominants are wanted for social or economic values, involves nothing more nor less than the thorough scientific study of the subsere which was initiated by the original destruction of the climax. A forest, for instance, may be carefully and economically handled so as never to interfere materially with the rejuvenation of the valuable trees. Also, a cattle range may be managed in such a way that it will provide the maximum feeding capacity from the range taken as a whole over a period of years. Such treatment means—translated into the language of succession—that the sere [2] is never thrown back farther than necessary, the subsere is kept as short as possible, conditions retarding the successions are avoided, and those favoring it are fostered or even artificially introduced. It may be, of course, that the valuable trees, or forage plants, are not the climax dominants at all, but members of an earlier phase. Then the climax is prevented from developing and the succession is not thrown back farther than is avoidable beyond the valuable phase.

Disturbance processes, and their effects upon cover and soil, serve as a basis for attacking the problem of erosion control. According to H. L. Shantz, "The whole program is primarily a job for the botanist, be he ecologist, agronomist, or forester. Under all cases, plants bind down the soil material and prevent its washing away. Erosion starts as a result of destruction of the plant cover. To reestablish this cover is a problem of agronomic or forest practice and, generally, must follow the course of secondary successions. Secondary successions are Nature's attempt to heal a wound in the earth's natural cover. The stages of reestablishment can easily be worked out, and in all cases, recovery is most rapid when there is no further interference by partial or total destruction of the plant cover. To remove continually the weeds from a deserted farm area on the high plains, is to retard the reestablishment of the short grasses. But the presence of weeds may be a sign of improvement or retrogression and only a trained ecologist can determine which process is taking place. It is all important, if man is to direct the reestablishment of our depleted range land, that he know the natural stages of revegetation, in order that he may further the natural recovery rather than retard it. Only a trained field man can determine the amount of damage done on the overgrazed ranges or to eroding soils." [3]

[2] Sere.—As a vegetation develops, the same area becomes successfully occupied by different plant communities. This process is termed "plant succession" and the successive stages "seres."

Clearing and Cultivation

Beginning with the advent of man, the clearing of the broad forest expanses with their dense undergrowths of vegetation, and cultivation of the land has exposed these forest soils to the action of water and wind. Experiments have shown that under natural conditions, run-off and erosion from forested areas is slight. W. C. Lowdermilk has demonstrated that this is due to the litter and humus which keeps the soil porous, thus allowing penetration.[4]

Exposure of soils through clearing and cultivation, especially on slopes of varying gradients, generally greatly accelerates the process of erosion, and unless effective farm management systems are initiated, the dark-colored organic matter, or humus, is carried away. The amount of percolation is greatly decreased and water is lost rather than stored. Plant foods are removed and, if the soils remain exposed, the subsoils as well as surface soil materials are washed away.

Grazing

Stock ranges in the West were originally dominated for the most part by that climax species which usually consists of strong, vigorous, palatable, perennial grass plants. The disturbance processes of heavy grazing and trampling, aided by drought, have affected these ranges and changed the vigor, density, and composition of the original vegetation. At first, vigor of plants was affected by continuous cropping, which caused a shortening of the root systems as well as a decrease in stature of the upper parts of the plant. With lessened vitality, the dominant, or climax species, were not able to compete with subdominant species. In some areas of the Southwest, for instance, continued use of the dominant black grama permitted the subdominant burro-weed to increase greatly in abundance. With

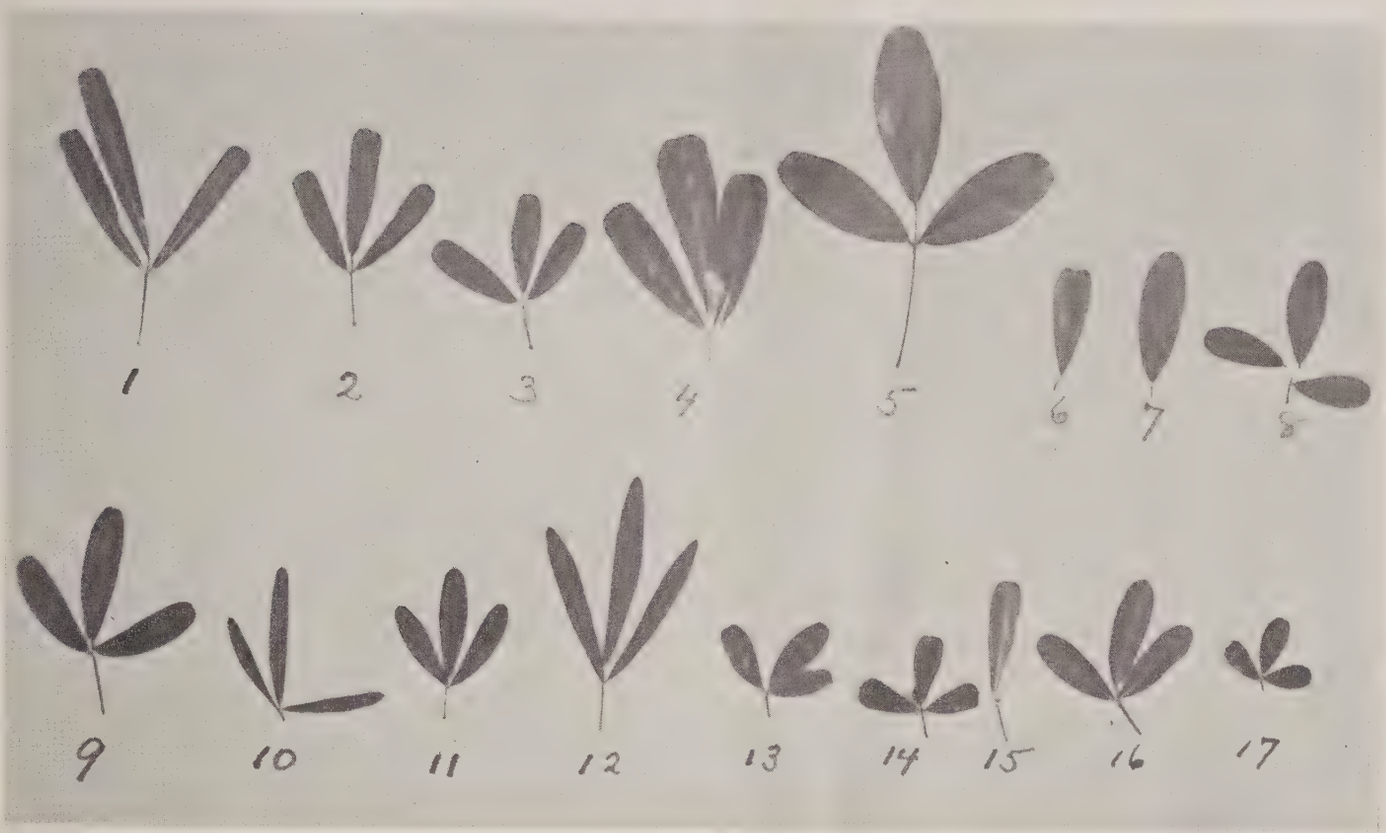
(*Continued on p. 270*)

[3] H. L. Shantz: Challenge of Erosion to Botanists. Iowa State Journal, sec. 9, pp. 353–363. 1934.

[4] W. C. Lowdermilk: Influence of Forest Litter on Run-off, Percolation and Erosion. Journal of Forestry, vol. 28, pp. 474–491. 1930.

Some Lespedeza Relationships

By A. J. Pieters [1]



Lespedeza leaves, nearly natural size: 1–4, L. sericea; 5–8, L. inschanica; 9–11, L. juncea; 12, L. cystoides; 13–17, L. latissima.

THE lespedezas are of such definite interest in the soil conservation program that it is considered worth while to set down something of the taxonomic relationships of the species. No monograph of the genus has been written and it is necessary, therefore, to piece together our data from the various descriptions of the species, mostly Asiatic. P. L. Ricker, of the Division of Forage Crops and Diseases, has been working with the writer for several years on the taxonomy of the lespedezas and it is from these studies that this discussion has been drawn. The lespedezas occur as natives in only two great regions—eastern Asia as far west as the Himalayas, and eastern North America as far west as Texas. *Lespedeza sericea* has been recorded from Australia, but there is reason to believe that it is there merely as an introduction and is not truly indigenous, as is the case with the common annual in this country.

There are 125 species described under 185 names. Twenty out of the 125 species have been named from North America, though only 11 are common. This leaves 104 species in the Orient. Of this number, some 25 species have been grown in the nursery of the Bureau of Plant Industry. The American species do not occur in the Orient, nor are any oriental species indigenous to America.

Taxonomists place the species into four groups: Macrolespedeza, Eulespedeza, Campylotropsis, and Microlespedeza. The last named includes the only two annual species known, namely, *L. striata* (common lespedeza) and *L. stipulacea* (Korean lespedeza). These are so well known that they need not detain us. The first two groups are united under the term Archilespedeza, and this great group differs from the Campylotropsis group in that the keel of the flower is blunt or truncate instead of pointed and beaked, and that there are two flowers behind every bract instead of one. In general appearance some of the Macrolespedeza group resemble those of the Campylotropsis group. *L. bicolor* is an example of this in its resemblance to *L. macrocarpa*. The species of the Macrolespedeza group differ from those of the Eulespedeza group in having a four-parted instead of a five-parted calyx and in lacking the apetalous flowers; that is,

[1] Principal Agronomist, Soil Conservation Service, Washington, D. C. Formerly Principal Agronomist in charge, Division of Forage Crops and Diseases, Bureau of Plant Industry. The data presented in this paper was derived largely from research conducted by the Bureau of Plant Industry, and is published in collaboration with that bureau.

those that have no corolla and consequently do not show. The species of the Eulespedeza group have both inconspicuous but fertile flowers and conspicuous flowers. This is also true of the two annuals of the Microlespedeza group. The species native to the United States all belong to the Eulespedeza group.

Agronomically the lespedezas may be classed as annuals or perennials, and the latter again as shrubs or herbaceous perennials. Species such as *L. bicolor* are representative of the shrubs, while our native species, *L. sericea* and *L. juncea*, represent the herbaceous perennials.

This Eulespedeza group is of special interest as it contains several species that intergrade and are so much alike that it is often difficult to be certain with which species we are dealing. This "sericea group" of species consists of *L. juncea*, *L. sericea*, *L. inschanica*, *L. cystoides*, *L. caraganae*, and *L. latissima*. The specific distinction between these species is in the shape of the leaflet, though habit of growth also differs somewhat. Typical *sericea* is strictly erect, *juncea* and *inschanica* more bushy, while *latissima* is low and either procumbent or prostrate. These habit characters, while agronomically important, are not commonly considered in making botanical descriptions which are based on characters that can be checked from an herbarium specimen.

The typical leaflet of *L. sericea* (see drawings 1 to 4 inclusive of the illustration) is narrow at the base, broadest at the apex, and with the end truncate. The midvein extends into a spine. In *L. juncea* (drawings 9, 10, and 11) the leaflet narrows toward both ends from the middle and the apex is rounded, neither truncate nor acute. In *inschanica* (5, 6, 7, and 8) the leaflet is relatively wider but of the same shape as in *juncea*. The plants tend to be larger and more open bushes than in *juncea*. *Cystoides* (drawing 12) has a long narrow leaflet acute at the apex, while *latissima* (drawings 13 to 17 inclusive) has a stubby leaflet relatively broader and shorter than in *juncea* but again of the same general shape.

While the shapes of the leaflets as given above are correct in typical cases the variations are so numerous that few plants are found on which all the leaflets are typical. The shape and proportions of the leaflets on the lower part of a plant may differ from those on the upper part. The truncate end of the *sericea* leaflet may grade into a sloping shoulder and thus closely resemble the *juncea* leaflet as is shown in drawing 3 of the illustration. On some *sericea* plants leaflets have been found as in drawing 10, and these are difficult to distinguish from the leaflets of *juncea*. The *inschanica* leaflet is sometimes narrowed as may be seen in drawing 7, and this brings its shape closer to that in *juncea* and the leaflet of *latissima*, normally short and stubby, may be longer, as in drawing 16, and then it too approaches that of *juncea*. In some leaflets of *latissima* there is an approach to the *sericea* form, although the leaflet is shorter as shown in drawing 14.

On one plant of a perfectly flat growing selection at Arlington Farm, the leaflets are like those of *sericea* (drawing 15) though the habit of growth is that of *latissima*. Of course it is possible that this strain is the result of a natural cross between *sericea* and *latissima*. In *L. caraganae*, which has not been grown at Arlington Farm, the leaflets resemble those of *sericea* but are narrower and with retuse apex. An idea of how leaflet shapes vary can be had from a study of drawings 5, 6, and 7, all of which were taken from the same herbarium specimen. That shown in drawing 5 represents the lower stem leaves, 6 was found toward the end of the branch, and 7 at the tip. The leaf shown in No. 6 is typical *sericea* and 7 very close to *juncea*.

All this has agronomic importance: without proper knowledge of the species two or more workers may use the same name and yet be working with different forms. To the soil conservationist the habit of a plant as related to its value for erosion control is of more importance than the shape of the leaflet. It would appear advisable, therefore, to select and propagate at different nurseries the strains or species that prove useful under specific conditions, leaving to the taxonomist the difficult task of applying the correct name. In some instances, there is little doubt that no two taxonomists would agree, and the same specialist might express a different opinion on two lots from the same plant.

Field men having plantings of erect plants with most of the leaflets as in drawings 1, 2, 3, and 4 can safely call them *Lespedeza sericea*. Where the plants are more bushy and less strictly erect with the leaflets, or most of them, like those in drawing 9, the species doubtless is *juncea*. It is not probable that any plantings of *inschanica* will occur, but where plants are more open in habit than are *sericea* or *juncea* and the leaflets generally larger—especially on the lower parts—they probably should be classified as *inschanica*. *L. cystoides* will not be found, and *latissima* is readily distinguished by its nearly or quite prostrate habit of growth.

Another article by Dr. Pieters, "The Native American Lespedezas," will appear in a future issue.

What We Have Learned About Terrace Spacing At Guthrie, Oklahoma

By A. E. Brandt [1] and G. W. Musgrave [2]

AN ANALYSIS of results from experiment No. 1 at the Red Plains Soil Erosion Experiment Station at Guthrie, Okla., shows that the percent of precipitation which runs off terraced land is negatively correlated with the vertical spacing of the terraces. To be specific, the average of the run-off, stated in percent, for eight rains of sufficient intensity to cause soil loss, was 54.5 for the 2-foot terraces, 46.5 for the 3.5-foot terraces and 41.7 for the 5-foot terraces.

Run-off as Percent of Precipitation for Principal Rains During 1933

Rain number	Vertical spacing		
	2 feet	3.5 feet	5 feet
1	50.4	39.0	35.4
2	59.3	69.0	58.0
3	52.6	47.3	49.0
4	25.3	20.1	12.9
5	48.0	38.6	29.2
6	72.2	58.9	55.4
7	57.1	50.8	50.8
8	69.1	48.6	43.0
Mean	54.3	46.3	41.7

Another analysis of results from the same terraces shows that the percent of precipitation lost as run-off tends to be positively correlated with vertical spacing, but that either the 2-foot or 5-foot spacing is quite superior to the 3.5-foot spacing for conserving water.

Run-off as Percent of Precipitation for Principal Rains During 1936

Rain number	Vertical spacing		
	2 feet	3.5 feet	5 feet
1	38.5	47.8	38.1
2	25.4	32.8	22.0
3	21.8	27.6	22.6
4	71.5	75.4	63.3
5	53.8	52.5	38.4
6	0	45.8	36.4
Mean	35.2	47.0	36.8

A third analysis of data from the same terraces shows, as does the first analysis, that the percent of precipitation lost as run-off is negatively correlated with vertical spacing, but the 5-foot spacing shows a greater superiority than previously. As in the second study, however, the 3.5-foot spacing is not in line with the other two spacings—that is, there is a difference in run-off of 2.4 percent between the 2-foot and 3.5-foot spacings but that between the 3.5-foot and 5-foot spacings is nearly seven times as great, 16.6 percent.

Run-off as Percent of Precipitation for Principal Rains During 1935

Rain number	Vertical spacing		
	2 feet	3.5 feet	5 feet
1	18.8	22.4	6.2
2	66.5	53.0	34.8
3	41.5	62.3	24.8
4	79.2	86.7	44.2
5	64.4	56.4	51.0
6	70.8	68.7	70.1
7	98.7	93.1	77.5
8	32.6	26.0	25.2
9	84.8	67.0	62.3
Mean	61.9	59.5	42.9

Ecologic Research

Many writers, especially those searching the literature for evidence to prove a point, select data such as tabled above. It is customary in such instances to say that a close study or a statistical study shows conclusively, or proves beyond doubt, that the particular thesis is true. Generally speaking, such a person is an upright and honest searcher after truth and he feels that because some numbers add up in a special way in the table presented by him, the point has been proved. Unfortunately a conclusion reached in this manner is liable to be erroneous as only the magnitude of a difference has been considered whereas it is essential to consider its probable range of variation as well. An estimate of this probable range of variation can be secured if the treatments or experimentally controlled variables are replicated, but it will be valid only if properly randomized.

This variation or variability is the basis of the modern statistical advances concerning tests of significance and the design of field experiments. Some research workers are inclined to blame modern statisticians and modern experimental designs for this

[1] Senior mathematical statistical analyst, Division of Research, Soil Conservation Service, Washington, D. C.

[2] In charge, soil and water conservation experiment stations, Division of Research, Soil Conservation Service, Washington, D. C.

variability and its prominent place in research when, as a matter of fact, it is inherent in the living material used in the experiments. Though this matter of unreliability of results from experiments is a very live subject of discussion, it is not new. Robert Boyle, writing in 1763 "concerning the unsuccessfulness of experiments" said, "I am very sorry, Pyrophilus, that to the many (elsewhere enumerated) difficulties which you may meet with, and must therefore surmount, in the serious and effectual prosecution of experimental philosophy I must add one discouragement more, which will perhaps as much surprise as dishearten you; and it is, that besides that you will find (as we elsewhere mention) many of the experiments published by authors, or related to you by the persons you converse with, false and unsuccessful (besides this, I say), you will meet with several observations and experiments, which, though communicated for true by candid authors or undistrusted eyewitnesses, or perhaps recommended by your own experience may, upon further trial, disappoint your expectation, either not at all succeeding constantly or at least varying much from what you expected."

A somewhat common belief among field experimenters is that an exact and invariable answer to a given question can be secured if conditions can be so controlled that there is but one variable. A weakness in this argument is apparent if one considers that but a few sources of variability can be controlled and the variability from other sources is ignored. It is often argued, however, that if a representative field of sufficient size be used these other sources of variability need not be considered.

Experiment No. 1, data from which are presented in tables 1, 2, and 3, consists of 6 terraces each 700 feet long with a channel grade of 4 inches per hundred feet placed on a uniform slope at vertical spacings 2, 3.5, and 5 feet. The numbers of the terraces and their vertical spacings are: 1E, 2 feet; 2E, 3.5 feet; 3E, 5 feet; 4E, 5 feet; 5E, 3.5 feet; and 6E, 2 feet. The numbering runs from the bottom of the slope to the top. Records of the percent of precipitation lost as run-off, and of the soil lost, were kept for the years 1932 to 1936, inclusive. The records for those rains which produced measurable soil loss are used as a basis for this study.

The figures in the body of each of the tables (1, 2, and 3) are the means of two terraces of the same slope for the years 1933, 1936, and 1935, respectively. In view of the apparent contradictions displayed in the tables above, the question naturally arises as to whether or not the data for the entire period are consistent enough for any inferences to be made.

By a rather simple arithmetic process, it was found that there is a very definite tendency for the percent of precipitation lost as run-off to be greater from terraces having a 2-foot vertical spacing than from those having a 5-foot spacing. For a given slope, the distance between terraces is less for a 2-foot vertical spacing than for a 5-foot spacing, resulting in a shorter time for concentration of water in the terrace channel for the narrower spacing which diminishes the effective time during which the soil may absorb the water running over its surface. It seems that the inference is logical.

There is a tendency for the run-off from the terraces having a 3.5-foot spacing to be greater than the mean for those having 2-foot and 5-foot spacing. Though the evidence provided by this experiment is not strong enough to generalize, this point should be kept in mind in further studies.

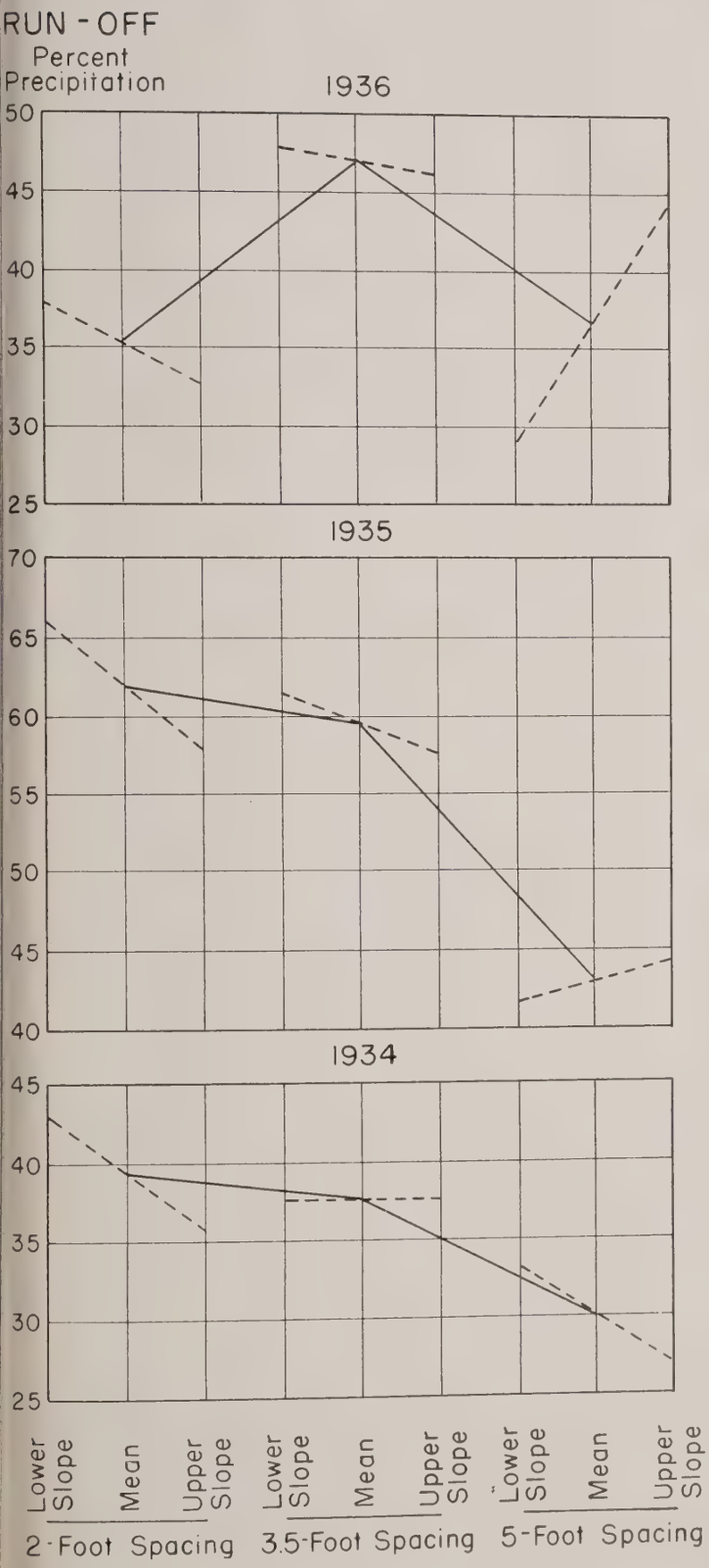
The totals for the 5-year period show a tendency toward the loss of a larger percent of precipitation from terraces in the lower half of the slope than from those in the upper half but this varies too greatly between spacings and years to be of much significance.

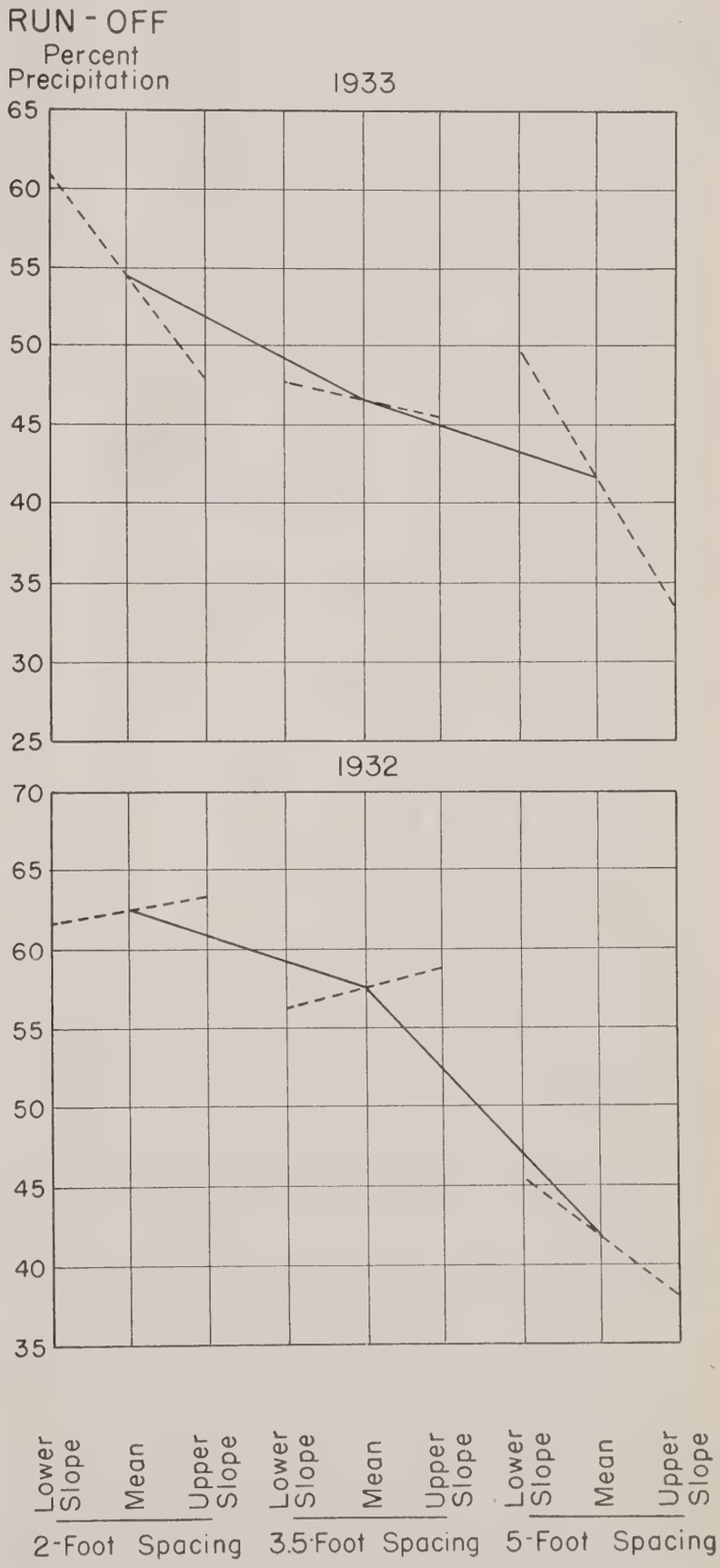
The data from this experiment are herein presented in graphical form. By plotting the mean annual run-off from the two terraces at each spacing against the spacing for each year, a general impression of the tendency of percent run-off to be negatively correlated with vertical spacing is given while the picture of yearly variation is retained. A more complete picture of the variability encountered is given by plotting the results from each terrace for a given spacing in addition to the mean.

A similar examination of the data on soil loss in tons per acre from the six terraces over the 5 years was made. The totals indicate that the soil loss is greater from the 5-foot terraces than from the 2-foot, but when this difference is compared with the variability in the results from terraces of the same spacing it hardly seems significant. This situation may indicate three distinct answers as follows: First, that the terraces of the different vertical spacings are equally effective in controlling erosion; second, that the method of measuring soil loss reflects only the behavior of the terrace outlets which were alike in this experiment and not the soil movement or erosion throughout the whole terrace area; or, third, that the method of measuring soil loss is so inaccurate as to increase unduly the variability of results from a given terrace. If either of the first two answers is correct, a change in the design should determine which within a few years' time. If, however, there is a bias due to inaccuracy of the determination of soil loss, no amount of experimentation with the same or a different design will correct it.

RELATION OF VERTICAL SPACING OF TERRACES TO RUN-OFF

On Experiment Number 1 —— At Red Plains Erosion Experiment Station





BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

TERRACING FOR SOIL AND WATER CONSERVATION. By C. L. Hamilton. U.S. Department of Agriculture Farmers' Bulletin 1789. Washington, D. C. April 1938.

This bulletin has as its objective the proper construction of terraces and suitable supplemental tillage practices to ensure good farm crop production on sloping agricultural lands without excessive soil loss. The detailed discussion incorporates the experiences and studies of the engineering section of the Soil Conservation Service and, in addition, a great deal of valuable information collected by field engineers at various soil and water conservation experiment stations. This, together with specific directions for terrace construction and farming practices on terraced lands, constitutes a most valuable compilation of the best information now available on the subject.

As the first factors to be considered in terrace system designing, the surface slope and rate and velocity of run-off are emphasized, and types of terraces for surface drainage and to increase rainfall absorption in the control of wind erosion are described as to function and adaptability. Photographs and cross-section charts illustrate the bench terrace for use on steeper slopes and show the inverted soil profile as developed by soil movement between terraces. The author then points out the fundamental principles involved in planning the terrace system—slope and soil observations, division lines between terracing units, natural and special outlets, diversion or interception ditches, tillage equipment available, and cropping practices to be employed ". . . to improve the soil fertility, reduce the annual soil movements between terraces, and minimize terrace maintenance."

As the result of experimentation, Mr. Hamilton presents specifications for limiting land slopes and for terrace spacings, grades, lengths, and cross-sectional areas. A table included with the text gives recommended vertical intervals between terraces on various slopes and the corresponding horizontal distances, acreage of each terrace interval per mile or per 100 feet of terrace, and the feet of terrace required per acre of land. A graphic presentation of the tabular information is presented for the convenience of contractors, terrace surveyors, engineers, and farmers who prefer this medium for determining specifications for terraces on various slopes and acreages in both Northern and Southern States. Careful directions are given for using the chart.

The author states that preliminary staking is important in laying out the terrace system in order that all topographical features be accounted for, and that realinement is usually necessary on each proposed terrace ". . . to eliminate undesirable sharp curves, to obtain greater ease of construction, and to secure a finished terrace that will offer a minimum of inconvenience in later tillage operations." Before construction begins, the final check of the terrace and outlet locations should show that the entire lay-out will be satisfactory.

An especially useful section of the bulletin is that dealing with terracing equipment, as developed and improved within the past few years. Because of the importance of proper equipment for terrace construction, this issue of SOIL CONSERVATION is showing, on the back cover, a series of drawings illustrating the progression of terrace machinery.

ECOLOGICAL RELATIONS

(Continued from p. 264)

lessened vigor, reproduction also is affected and plants generally decrease in density; the composition of the stand is changed; the soil is exposed to erosion and run-off, and as in cleared areas the water fails to penetrate the soil to any appreciable extent. Under these conditions, the habitat cannot support as good a vegetative cover as the original one.

It is generally found that over much of our western range lands where once desirable species grew, less desirable species provide the present cover. The area is so vast that all stages of destruction occur at the present time. Some of the damaged ranges, as in the Great Plains and in higher elevations of mountainous regions, can be improved by proper range practice in relatively short periods of time. In other areas, as parts of the Southwest, heavy utilization has greatly impoverished the vegetation. To develop climax vegetation which has been destroyed, especially in critical areas subjected to frequent droughts, is probably not a matter of years but of centuries. [5]

[5] H. L. Shantz. ibid:

The other disturbance processes, such as fire, lumbering, draining, flooding, and construction, all have a tendency to destroy the cover, impoverish the soil and set the stage for induced erosion. However, an understanding of secondary successions will put an important tool in the hands of field workers whose problem it is to check erosion, reestablish a vegetative cover and improve the forage and timber resources. If the subject is to be dealt with intelligently and to the greatest advantage, it is not sufficient merely to record the existence and quantity of vegetation, but it is necessary also to study its behavior and potentialities.

In addition to the specific citations, material for this discussion was drawn freely from the following references:

Almack, John C., Research and Thesis Writing. New York. 1930.

Clements, F. E., Plant Succession and Indicators. New York. 1928.

Tansley, A. G., Practical Plant Ecology. New York. 1923.

Tansley, A. G., and T. F. Chipp, Aims and Methods in the Study of Vegetation. London. 1926.

Weaver, J. E., and F. E. Clements, Plant Ecology. New York. 1929.

Engineering and Irrigation Practices in Erosion Control[1]

For REFERENCE
Compiled by Mrs. ETTA G. ROGERS, Publications Unit

Field offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

Office of Information U. S. Department of Agriculture

The Border Method of Irrigation. Farmers' Bulletin 1243. Bureau of Agricultural Engineering. Issued February 1922, revised October 1937.

The Corrugation Method of Irrigation. Farmers' Bulletin 1348. Bureau of Agricultural Engineering. Issued August 1923, revised October 1931.

Pumping From Wells for Irrigation. Farmers' Bulletin 1404. Bureau of Agricultural Engineering. Issued May 1924, revised May 1934.

Farmstead Water Supply. Farmers' Bulletin 1448. Bureau of Agricultural Engineering. Issued August 1925, slightly revised June 1933.

Measuring Water in Irrigation Channels. Farmers' Bulletin 1683. Bureau of Agricultural Engineering. January 1932.

Terracing for Soil and Water Conservation. Farmers' Bulletin 1789. Soil Conservation Service. April 1938.

Bridge Piers as Channel Obstructions. Technical Bulletin 442. Bureau of Agricultural Engineering. November 1934.

Agricultural Experiment Stations

Capacity of Irrigation and Drainage Wells. Bulletin 182. Agricultural Experiment Station, Bozeman, Mont. December 1925.

Centrifugal Pump Tests. Bulletin 190. Agricultural Experiment Station, Bozeman, Mont. July 1926.

Construction of Small Dams for Farm and Community Use. Circular 154. Extension Service, North Dakota Agricultural College, Fargo, N. Dak. March 1937.

A Diker-Ridger. Bulletin 281. Agricultural Experiment Station, Bozeman, Mont. October 1933.

Farm Drainage Practice. Special Bulletin 149. Agricultural Experiment Station, University Farm, St. Paul, Minn. Revised July 1935.

A Homemade Centrifugal Pump and Other Water-Lifting Devices. Bulletin 324. Agricultural Experiment Station, Bozeman, Mont. August 1936.

How to Make and Use the McPheters Terracer. Circular 340. General Series 284. Oklahoma Agricultural and Mechanical College, Stillwater, Okla. 1937.

Inexpensive Methods of Gully Control. Extension Circular 741. Extension Service, University of Nebraska, Lincoln, Nebr., in cooperation with the U. S. Department of Agriculture. June 1933.

Irrigation Development in Montana: Part I. Water Supply. Bulletin 353. Agricultural Experiment Station, Bozeman, Mont. January 1938.

Irrigation of Field Crops in Nevada. Bulletin 96. Agricultural Experiment Station, Reno, Nev. 1919.

Irrigation Pumping Plants. Circular 66. Agricultural Experiment Station, Moscow, Idaho. September 1931.

Irrigation Requirements of Cotton and Grain Sorghum in the Wichita Valley of Texas. Bulletin 543. Agricultural Experiment Station, College Station, Tex. August 1937.

Nebraska Tractor Tests, 1920-1935. Bulletin 296. Agricultura Experiment Station, Lincoln, Nebr. Issued January 1936, reprinted May 1936.

The Place of Terraces in Tennessee Agriculture: Why Terrace? Publication 209. Extension Service, University of Tennessee, Knoxville, Tenn. November 1937.

Recommendations for the Control and Reclamation of Gullies. Bulletin 121. Iowa Engineering Experiment Station, Ames, Iowa. March 13, 1935.

Some Economic and Social Aspects of Irrigation in Montana. Bulletin 354. Agricultural Experiment Station, Bozeman, Mont. January 1938.

Terrace Maintenance. Circular 260. Extension Service, University of Georgia, Athens, Ga. October 1935.

Terracing Farm Land. Extension Circular 182. Argicultural Extension Service, University of Arkansas, Little Rock, Ark., in cooperation with the U. S. Department of Agriculture. April 1935.

Terracing Farm Land in Georgia. Bulletin 394. Extension Service, University of Georgia, Athens, Ga. Revised April 1935.

Terracing Farm Lands. Extension Circular 173. North Carolina State College of Agriculture and Engineering, Raleigh, N. C., in cooperation with the U. S. Department of Agriculture. January 1935.

Terracing in Mississippi by the Soil Erosion Index System. Extension Bulletin 34. Extension Department, Mississippi State College, State College, Miss. in cooperation with the U. S. Department of Agriculture. October 1937 (2nd Revision).

Terracing in Oklahoma. Circular 218, General Series 56. Oklahoma Agricultural and Mechanical College, Stillwater, Okla. Revised 1930.

Terracing to Control Erosion: A Profitable Farm Practice. Extension Bulletin 70. Extension Service, Kansas State College of Agriculture and Applied Science, Manhattan, Kans. August 1936.

Texas: A Terracing Pioneer. Bulletin 97. Agricultural and Mechanical College of Texas, College Station, Tex., in cooperation with the U. S. Department of Agriculture. 1937.

Water Supply for Orchards. Bulletin 367. Cornell University, Ithaca, N. Y. February 1937.

Miscellaneous

Drainage Basin Problems and Programs, 1937 revision. National Resources Committee. February 1938. 65c (paper cover) from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

NOTE: Farmers' Bulletin 1234, "Gullies: How to Control and Reclaim Them", which was listed in the November, 1936 issue of "Soil Conservation", is being revised by the Soil Conservation Service. The revised edition will be listed when it is available.

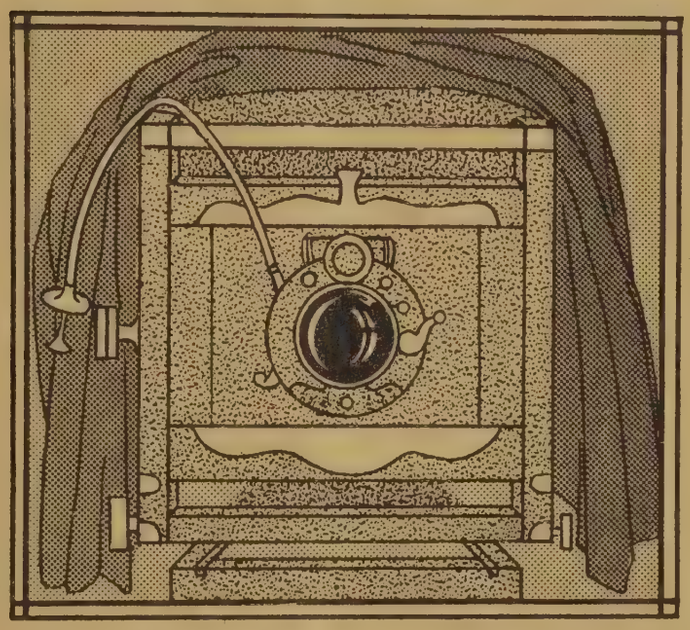
[1] For additional references to pertinent publications on these subjects, see lists in previous issues of SOIL CONSERVATION.

TERRACE CONSTRUCTION FOR SOIL CONSERVATION

ADAPTATION OF VARIOUS TYPES OF EQUIPMENT

SOIL CONSERVATION

FFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
NITED STATES DEPARTMENT OF AGRICULTURE · WASHINGTON



JUNE - 1938

A Camera Record of Problems and Progress

Restless and enigmatic, these shadowed dunes heave and creep. They are twenty miles south of Salton Sea, California.

Will sand waves such as these be reclaimed some day by grass or orchard or grain? Shall a modern economy concede the dunes a restricted existence?

The photograph to the right introduces this June issue because it symbolizes the dimensions and acuteness of the problem of erosion, hints at a broad range of answers, and leads to an interesting vista of opportunity in soil conservation through better land use --- an opportunity vital to the Nation, an opportunity as diverse as the soils and climate and human needs therein.

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

VOL. III • NO. 12

H. H. BENNETT
Chief, Soil Conservation Service

JUNE • 1938

ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON

The Pieces Fit Together

Compounded of many minds and measures and conditions, is the conservation of agricultural soils.

It is not enough to invoke the single spark of agronomy or the disciplinary hand of engineering. Real soil conservation merges the work of nature with the work of man. Vegetation joins with concrete, woodland with management, living soils with paper planning.

The picture puzzle (see opposite page) assumes meaning as the segments piece together. This is a depiction of the ideal. In aggregate and in detail, soil conservation consists of having the right plant in the right place; the thimble of water where needed, and when; the clod weighting down the dust particle; the grazing animal in control; the physical pattern basted to the dollar sign.

Wellington Brink & *Editor*

Soil Conservation is issued monthly by Soil Conservation Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. Soil Conservation seeks to supply to workers and cooperators of the Department of Agriculture engaged in soil conservation activities, information of especial help to them in the performance of their duties, and is issued to them free by law. Others may obtain copies from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of $1.00 per year, domestic; $1.40 per year, foreign. Postage stamps will not be accepted in payment.

Cause and Consequence

Proud of their home, prize of the community. This Minnesota family of 11 posed for the picture in 1900—a real event in those days. The photograph was of the kind for parlor albums and civic archives, evidencing the prosperity of fertile acres and an assured income.

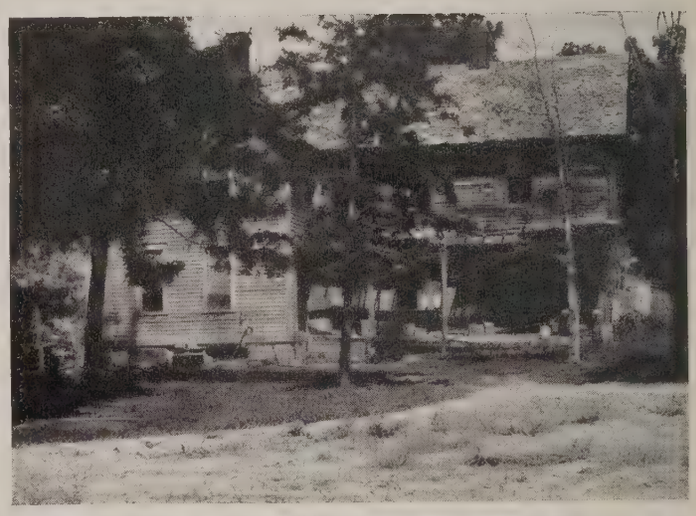
The house was built in 1888. A rock wall framed the flower-bedded lawn. Lattice work gave an attractive touch to the front porch.

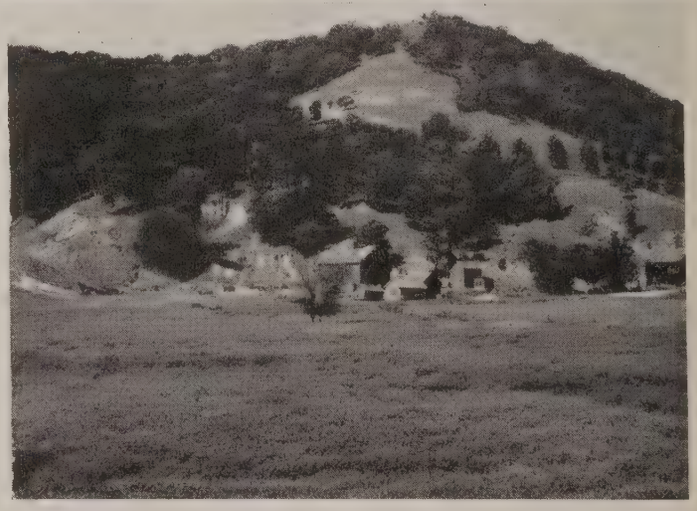
Can this be the same place? Yes, and part of the family still lives here. The glass is missing from many windows. The rock wall is buried in sand and silt. The old road is under 4 feet of washed-down deposits. The porch, once lattice-ornamented, looks lower, doesn't it? Even the trees are dying.

Here on this soil-robbed hillside is the close-up fingerprint of guilt. Ruthless erosion has left its undisputed mark.

Below the close-up is a more distant view of broken slopes and overgrazed pastures—appropriate background for dilapidated farm buildings which once set the local high standard.

The four pictures supply the continuity for a scenario which, projected in larger dimensions, serves to dramatize a national tragedy.



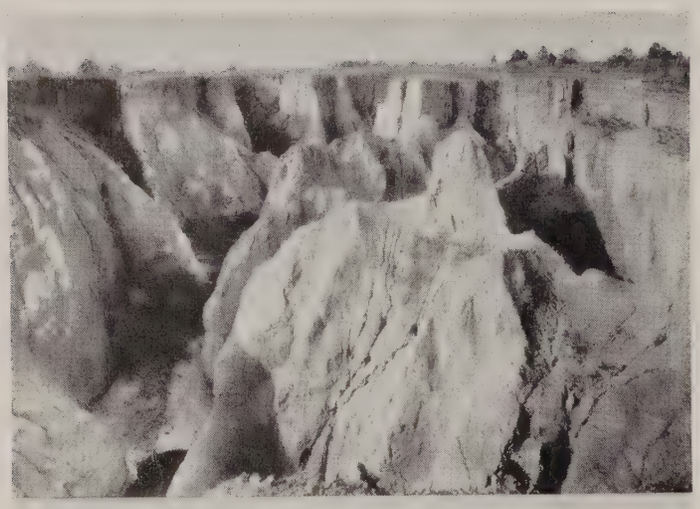


A DIFFERENT STORY—A HAPPIER DENOUEMENT. Another photographic old-timer, cracked and discolored, shows the Newman family dressed in Sunday best and lined up in front of their farmhouse near Cohocton, N. Y. This was right at the turn of the century, and the background shows great patches of brown amidst the green fields. Severe sheet erosion, the result of incorrect land-use, made the future look dismal.

Eighty-four-year-old Murray Tripp says that the hillside was cleared in 1875. And Mrs. Flora Newman Tripp can remember gathering potatoes when the whole slope between the stump fences at top and bottom was devoted to the growing of the tubers.

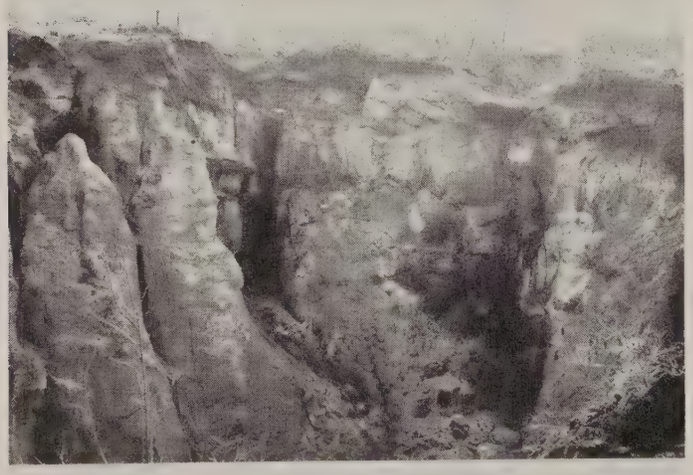
Twenty-five years ago the former farmhouse burned and was replaced by the one shown in the very recent picture at the bottom of this page. Harold Stanton is the present owner. The field sores are being healed up rapidly by conservation farming practices. Both house and fields reflect a different philosophy of land use—a philosophy in keeping with the times.

Gullies No Longer



Eye evidence—a pictorial inventory of definite results.

Almost unbelievable is the magic wrought by bulldozer blade, black-locust plantings, lespedezas, and small grain on gnawing gullies in South Carolina. The camera does not lie, and the completeness of the transformation is attested in these "before and after" scenes of the Berry gully near Spartanburg, S. C.—one of the first jobs of the kind completed on the South Tyger River project. From this gully each week over a period of 8 years was washed the equivalent of three 32-ton carloads of material. The gully drained less than 5 acres and was extending at a rate of 100 feet a year. When work began in 1933 it had ruined 40 acres of good bottom land.



Again, the wand of bulldozer, small grain, black locust, contour terraces, a diversion ditch at the head, and Bermuda sod on the terrace ridges. This stablization job pertains to a gully on the C. D. Entrekin farm near Switzer, S. C.

Pick Out the Landmarks

Right: A house and barn in Buffalo County, Wis., threatened with engulfment by a gully. Today they are protected by piling-bulkhead and rock-brush deflecting dams. Note the adequate fencing, the roadway atop the fill, the useful farm pond.

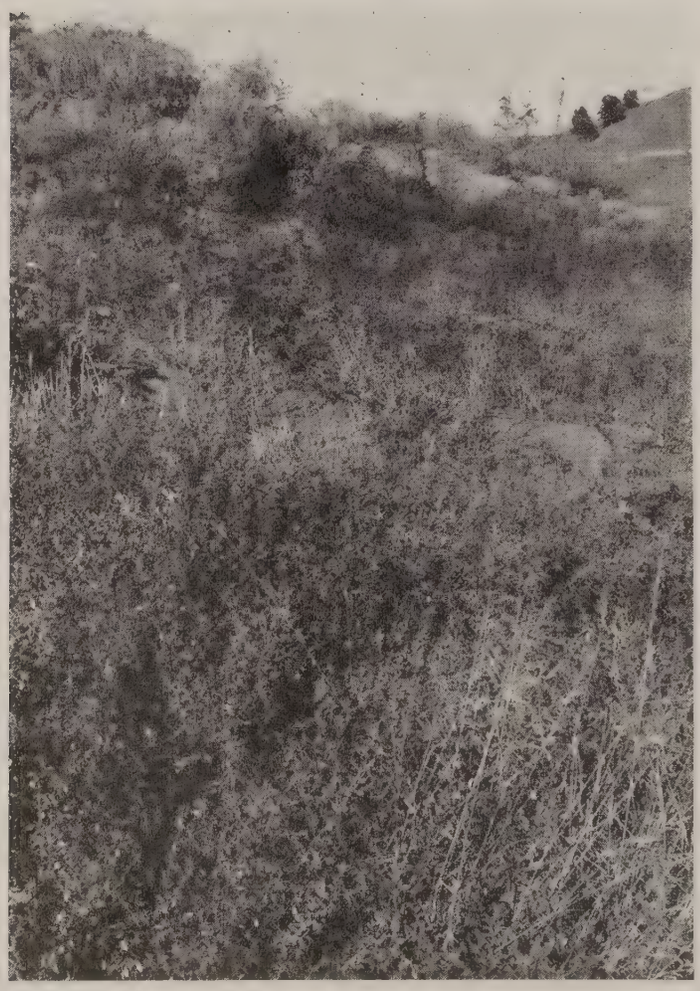
Relate the "As Is" to the "As Was"

Left: A sea of drifting sand, 6 feet deep in places, pounding at farm buildings in Beadle County, S. Dak. The "after" view attests the miracle performed by cover crop planting of cane and Sudan grass, listed on the contour.

Once Bare—Now Protected

Gone here, near Spencer, W. Va., not only the vegetation but the organic matter and a lot of the subsoil. The soil moves down so fast during a gully washer that few plants dare try to cover the surface.

Sweetclover and Korean lespedeza are among these few plants and in this later picture, given a favorable start by the Soil Conservation Service, they are making real headway.



This sunflower buffer strip has a threefold purpose: (1) To break the force of wind in summer; (2) to cause a deposition of snow next to new windbreak plantings, in winter; and (3) to provide food for wildlife.

Contrasts: Conservation

Are these the same farms? The answer is No—they are *better* farms.

At the top is the Lena M. Jefferson place, 4 miles northeast of Wolsey, S. Dak., in the spring of 1936. Subsoil is exposed, rocks show on the surface, despite emergency listing done for control purposes. Partial stabilization was effected that year by listing and by broadcasting oats.

By early August 1937, however, cane and Sudan grass as emergency cover crops had halted the erosional process and prepared the way for permanent stabilization of the land.

Immediately below, another Beadle County (S. Dak.) farm, as it responded to identically the same agricultural prescription—cane and Sudan grass listed on the contour.

These good farm buildings were abandoned during the 1935 drought and dust storms. During that season soil drifted 6 feet deep around these structures. Record dry weather in 1936 retarded stabilization. The cover crops were seeded in 1937 and by early August had provided effective protection against further blowing, giving promise of permanent stabilization and possible reoccupation under proper soil and moisture-saving methods.

A cavity that was giving trouble in Wisconsin. Gully heads were advancing at the rate of 40 feet per year.

Control—thanks to a drop inlet structure.

68516—38——2

Faithful guardians of the good earth. Leaf, twig, limb, bark, and clinging root and rootlet sift the rain; build and hold the soil.

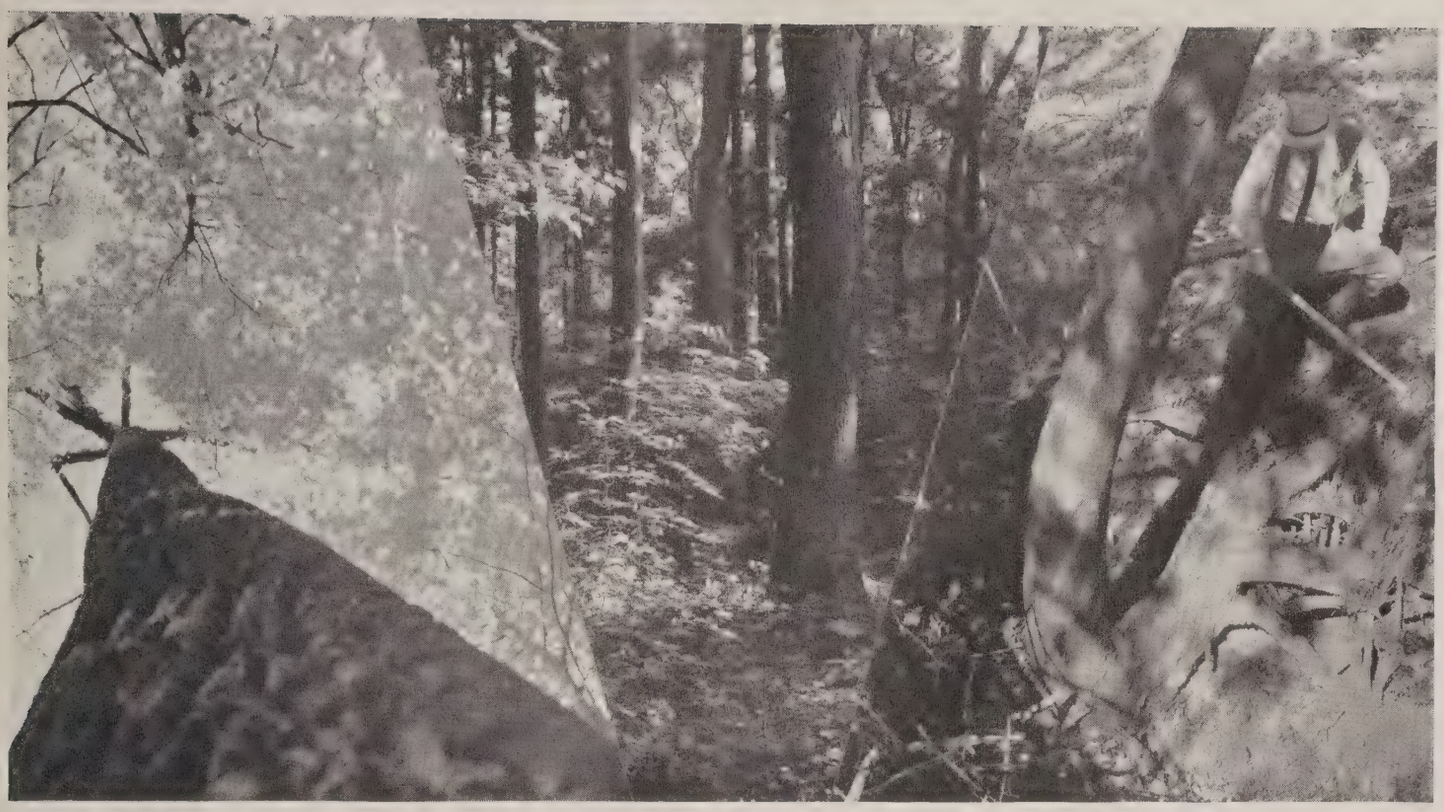
Trees must be protected, if they are to protect. Part of the complete soil conservation program is farm woods—managed farm woods. And part of management is fencing to keep out livestock; pruning, thinning by selection, shrubbery borders to weaken wind stress, and to provide food for feathered friends.

The 185,000,000 acres now in woods on farms in the United States and the possibility that this area may reach a total of 250,000,000 are indications of the magnitude of this problem; another concerns farm fields which should be used for trees and shrubs.

By the close of 1937, farmers had agreed to operate 1,549,000 acres of their holdings in accordance with principles of forest management drawn up by Soil Conservation Service foresters for each tract. This frequently involved the preparation of comparatively detailed, though simple, plans based upon growth data, required farm needs, and the growing stock. Each plan fits definitely into the complete farm program as worked out by technicians.

A total of 350,000,000 trees and shrubs had been planted on approximately 217,500 acres at the close of 1937. Although locust and various species of pine predominate in the list, many other species adapted to the various sites have been used.

Other means of interesting the farmer in appreciating the farm woods, as a means of erosion control and profit, have already included the demonstration of woodland management on almost 25,000 acres in the woods of more than 5,000 cooperating farmers.



Trees, litter, undergrowth combine to defeat the erosional process.

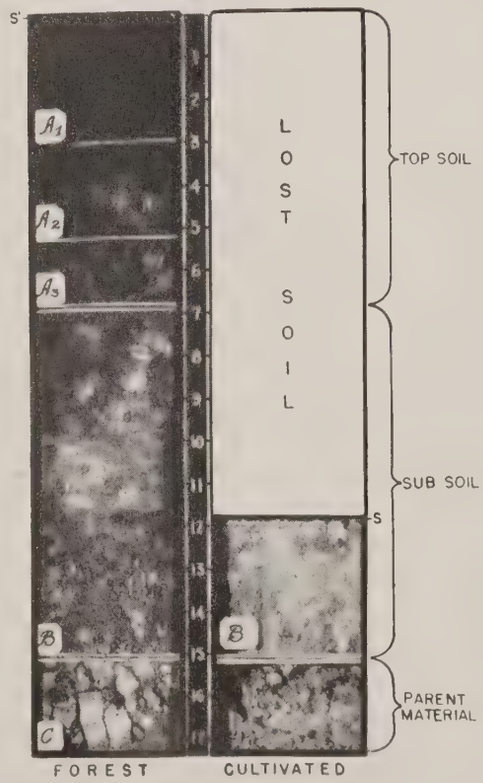
A worm's-eye view of a tulip poplar.

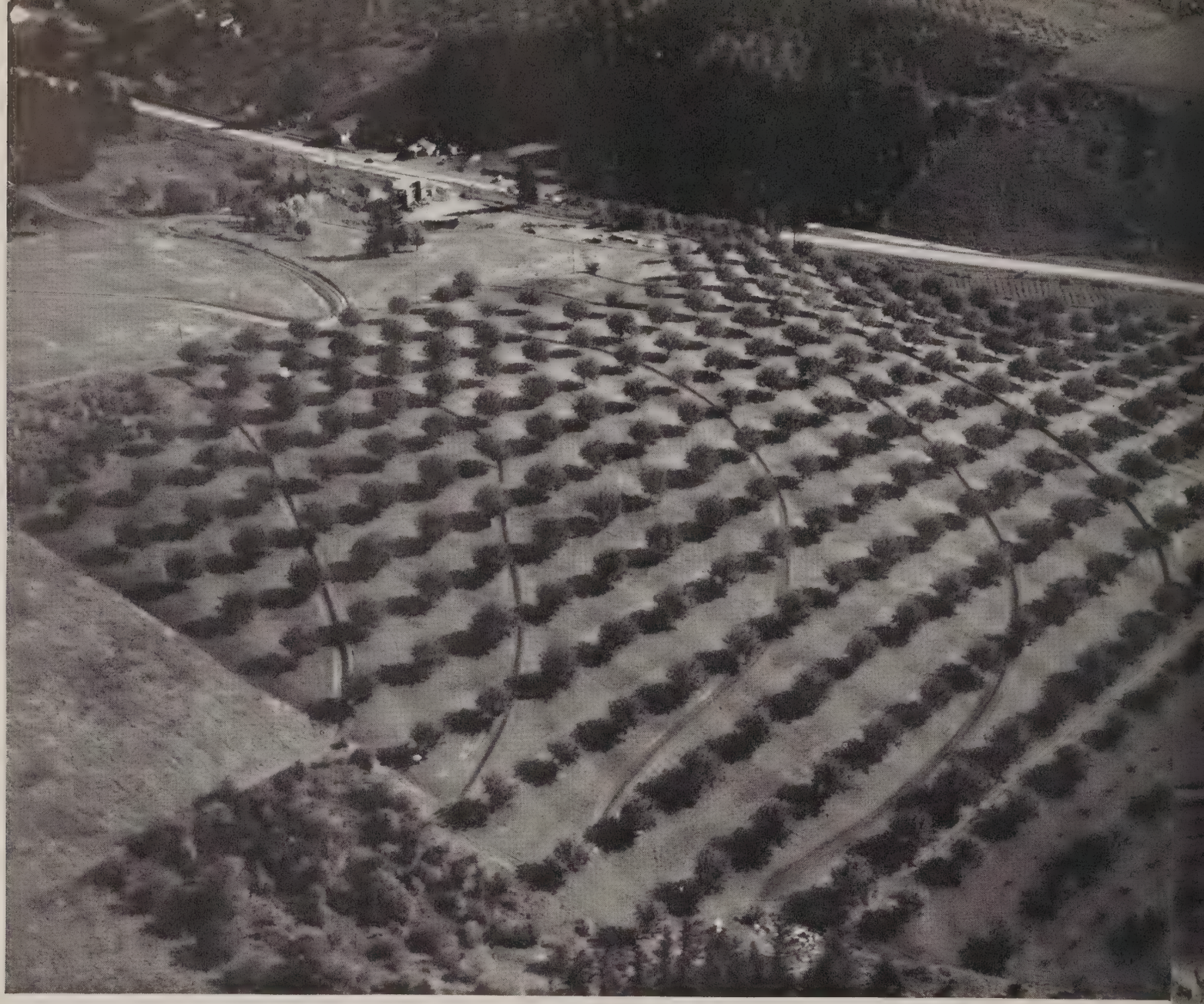
Toes gripping the soil—a freak growth illustrative of the way forest feet circumvent shifts and losses of soil.

TITLE PICTURE OPPOSITE

Corner of a 20-acre field completely enclosed by windbreaks. Snow, unblown, sometimes has piled 5 feet deep, storing moisture for the growing season.

COMPARISON OF EROSION UNDER FOREST COVER AND ON CULTIVATED FIELD





(Right)

Strip cropping, both contour and straight, as practiced on the Goshen Hole erosion-control area 38 miles west of Torrington, Wyo., in the fall of 1937.

In the foreground of this air view are 48-foot contour strips on the F. A. Schamel farm; right, adjacent, are 10-rod wind strips on the C. F. Goertz place.

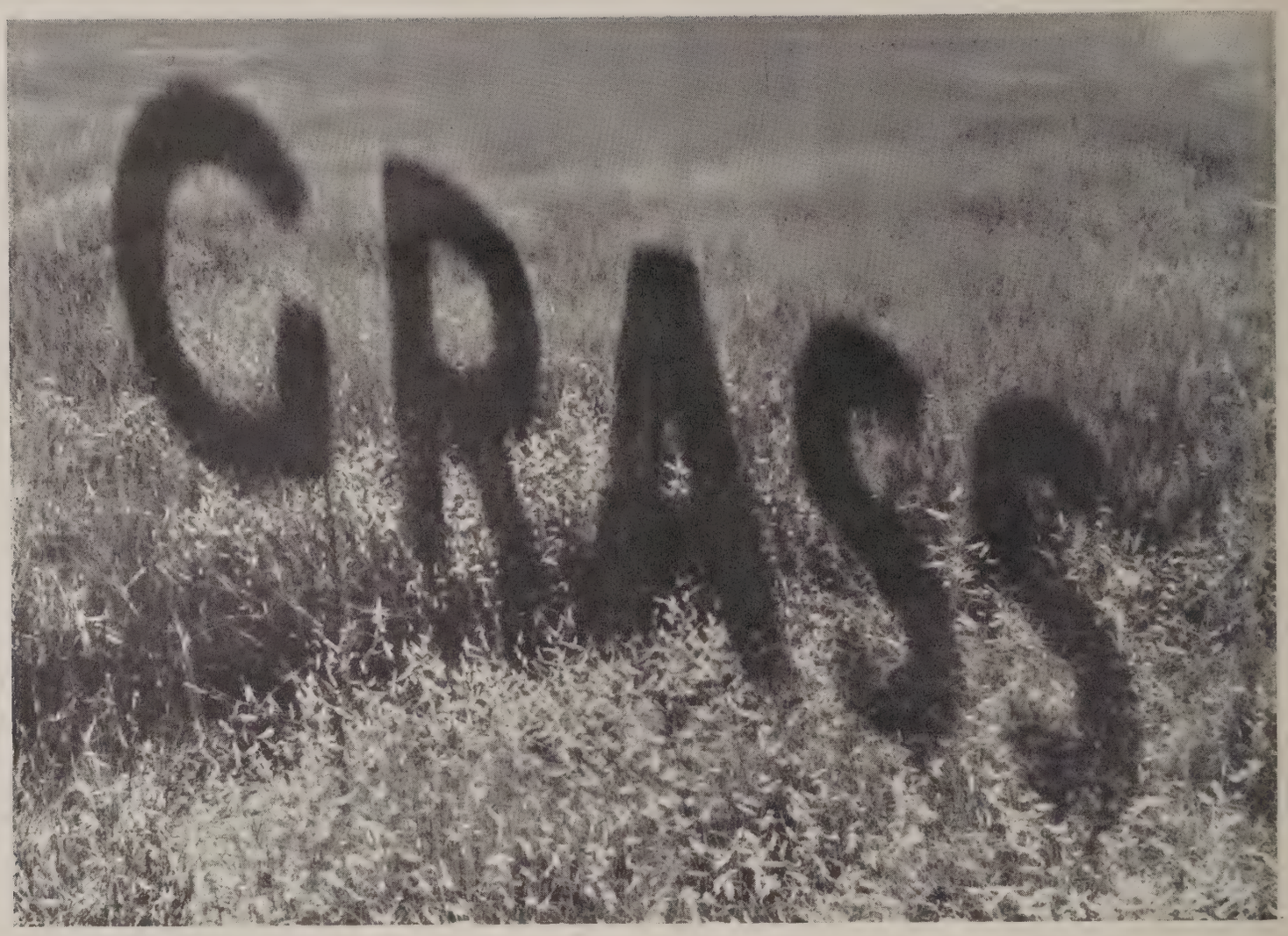
A portion of the escarpment circling the area is discernible in the left background.

(Left)

This 26-acre walnut orchard on the farm of Helen Whitaker, 4½ miles northeast of Newberg, Clatsop County, Oreg., was diversion-ditched by the Soil Conservation Service in the summer of 1937.

The ditches are of the standard 2-foot narrow-base drainage type terrace, spaced at 20-foot vertical intervals. They have a gradient of from one-fourth to one-half percent and drain to a sodded outlet. The three in the middle were seeded to grass which it is planned to maintain permanently.

The walnut trees are 20 years old, set 60 feet apart. Slopes, 10 to 30 percent. Soil, Olympic silty clay loam.



"Grass is the forgiveness of Nature—her constant benediction. * * * Beleagured by the sullen hosts of winter, it withdraws into the impregnable fortress of its subterranean vitality and emerges upon the solicitation of Spring. Sown by the winds, by wandering birds, propagated by the subtle horticulture of the elements, which are its ministers and servants, it softens the rude outline of the world. Its tenacious fibers hold the earth in its place, and prevent its soluble components from washing into the sea."—*John J. Ingalls.*

Picture 1. The thick matting of Bermuda grass in this waterway must be pressed down to the floor of the channel, to prove that a good amount of water is actually passing.

Picture 2. Action of water in meadow strip featured by sod baffles.

Picture 3. Western wheat grass sods this terrace outlet channel.

Picture 4. Burning of stubble is a common practice which often leads to lowered yields and wind-erosion disaster.

Picture 5. Isolated hummocks held by vegetation. Concentration of livestock around watering places kills grass and invites erosion.

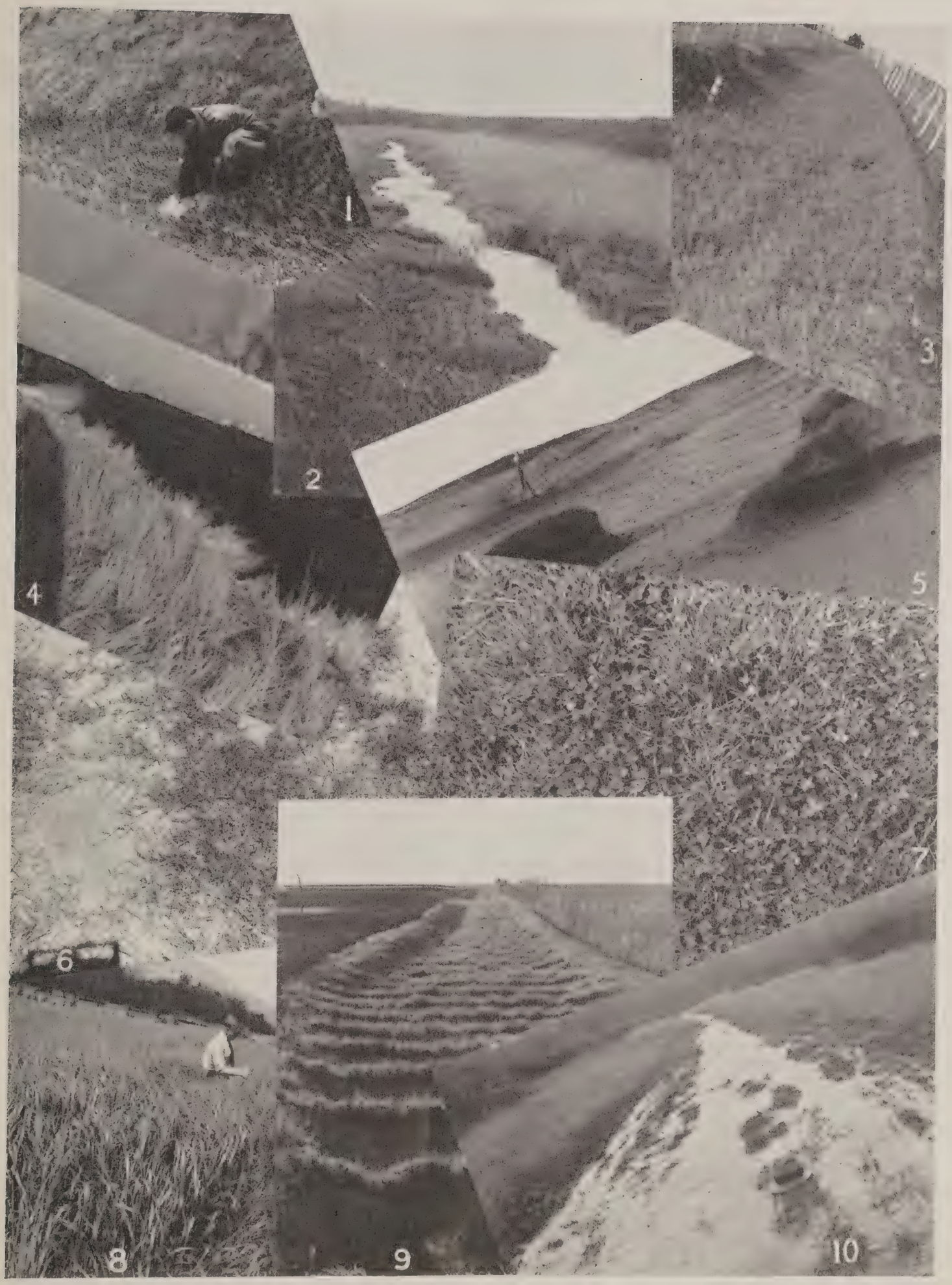
Picture 6. Buffalo grass, shown here in a terrace outlet channel, spreads by sending out runners which root to form other plants.

Picture 7. A good turf consisting of grasses and clovers produces abundant feed and provides control against loss of soil and water.

Picture 8. Alkali ryegrass in nursery.

Picture 9. Large volumes of water are discharged from terraced fields without damage; this channel was seeded to grass with a strip of oats every 10 feet.

Picture 10. In this meadow strip the water is spread out. The blades of grass lie flat in the channel, and erosion is negligible.


1
2
3
4
5
6
7
8
9
10

700 Years in Grass

The scenes on this page were taken on a farm in Leicester, England, by C. R. Enlow, in charge of the agronomy and range management section, during the International Grassland Congress in 1937. The farm's 400 acres are entirely in grass, mainly perennial rye and wild white clover. The pastures are generations old, the bedding effect observed on the far slope of the picture below having been achieved when the land was cultivated 700 years ago.

The owner buys his cattle and sheep and sells grass-fattened animals once, and sometimes twice, a year. He guards against both overgrazing and undergrazing, and gets an average of 280 pounds of beef and 80 pounds of mutton per acre.

Mr. Enlow was on four of the pastures. He found them grazed to a height of approximately 2 inches, with numerous tussocks of grass around the droppings which were scattered during the winter. These pastures, like all good English pastures are fertilized liberally, usually with basic slag.

English farmers invariably graze cattle and sheep together. The Cockle Park Experiment Station has found through a 21-year experiment that for every pound of liveweight increase per acre obtained from grazing with sheep alone on Tree field, 2 pounds per acre were obtained on the Hanging Leaves plot stocked with cattle and sheep. Much better utilization of the forage results from grazing cattle and sheep together.

TWO SIGNIFICANT ISSUES

Tentatively scheduled for July and August are special issues of more than ordinary importance. Each will be devoted to the subject of better land use—the first discussing program, the second pertaining to planning.

Among the contributors will be Secretary Wallace, the chiefs of the several bureaus immediately concerned, and the Department's coordinator of land-use planning.

STRIPS

Contour strip cropping is a practice that was picked up from farmers in Wisconsin, New York, Pennsylvania, Ohio, and West Virginia who are farming rolling land and fairly steep hillsides. On some farms, a modified form of strip cropping has been carried on for many years.

Contour strip cropping is a general practice in some localities in France on rolling land. Small grains, legumes, and root crops are used in rotation on the strips.

Since the Soil Conservation Service was started in the fall of 1933, 879,532 acres of land on SCS projects and camps throughout the country were contour strip cropped by December 31, 1937. On some project areas, the practice is almost universal, and many farmers who farm land adjoining the projects have taken up the practice.

This practice is not a cure-all. On long slopes, and particularly where a distinct "erosion pattern" has been formed and the best of the soil has been washed away, strip cropping should not be attempted without first constructing terraces or diversion ditches to dispose of the excess water.

Contour strip cropping is a practical method of farming on erosive slopes with a minimum loss of soil. It is merely a field arrangement and can in no way substitute for the use of proper crop rotation. In fact, an excellent strip cropping system embodies the best crop rotations. The rotations can be worked out by strips or by fields so that wheat stubble and hay aftermath can be grazed. Strip cropping is readily adapted for the livestock farm. For cash crop areas, it leads toward diversification, which is so essential to a truly permanent agriculture.

Our agriculture is not set up along proper land-use lines. Many farms have little level land to till but crops must be grown to furnish an income. If we expect to carry on a truly permanent agriculture on sloping, erosive land, it means every possible method of controlling erosion and maintaining the organic matter content of the soil must be employed. The use of lime, fertilizers, and soil-improving crops must be supplemented by terracing and the best possible arrangement of our crops on the land. Contour strip cropping has a real place in this program.

TERRACES

Since 1934 more than a million acres of crop land have been terraced as a result of the Soil Conservation Service demonstration project and camp activities. A compilation of Department of Agriculture Extension Service Reports indicate that several million acres have been terraced as a result of county agent activities from 1915 to date. It has been estimated that previous to 1915 bench terraces and hillside ditches in the southern States were used on about two million acres and the narrow ridge-type terrace on an equal acreage.

The development of terracing as recommended today has required years of use, extensive field observations and experimentations, and many modifications from time to time in construction procedure. When terraces are properly used and constructed and adequately supported by approved cropping and tillage practices they provide one of the most effective erosion - control measures applicable to cultivated lands. When improperly constructed or not coordinated with proper land-use practices they often accelerate rather than retard soil losses.

CONTOUR FURROWS

Contour furrowing is relatively new, but it has proved very beneficial on range and pasture land, particularly in western semi-arid regions. It improves both the quality and quantity of vegetative cover. More than 401,000 acres have been furrowed or ridged in project and camp areas.

Contour furrows are small and constructed on the contour. In humid areas their primary function is soil conservation, while in areas of low rainfall it is conservation and distribution of moisture that would otherwise be lost. The amount of water they can retain depends upon their water cross-section area, their spacing, and the absorption characteristics of the soil. To obtain uniform distribution of moisture, spacing should seldom exceed 10 feet.

Most contour furrows have been made by moldboard plows, listers, graders, and subsoilers. The most satisfactory ones are obtained by low cost machines, which do the work without destroying existing turf. Several attempts have been made to develop special machines for the purpose.

SPECIALIZED MACHINERY

Typical of the specialized equipment to meet the new requirements are the devices pictured here: (1) Heavy type sod cutter for cutting native sod strips; (2) experimental strippers developed for harvesting native grass seed; (3) seed pan used for harvesting seed crops on small areas; (4) mole drainage plow used for underground drainage; (5) homemade subsoiler made from a tractor plow; (6) basin lister; (7) one-way disc plow used in Northwest to establish trashy fallow; (8) another type of contour furrowing machine, working in native sod.

Results, at a Glance. What the experiment stations show.

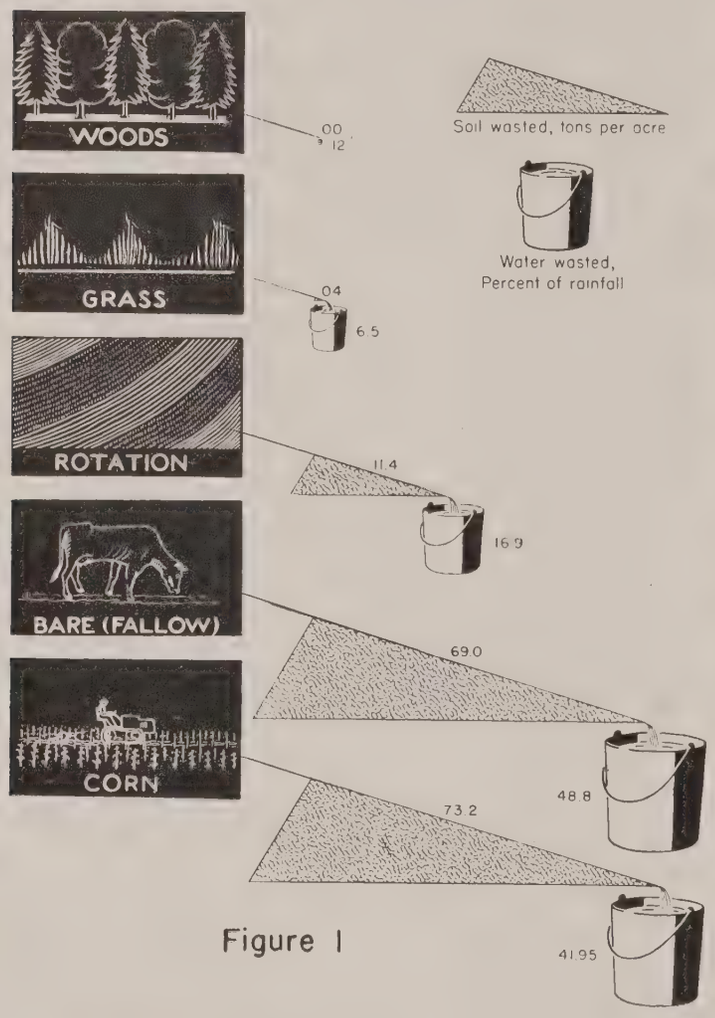


Figure 1

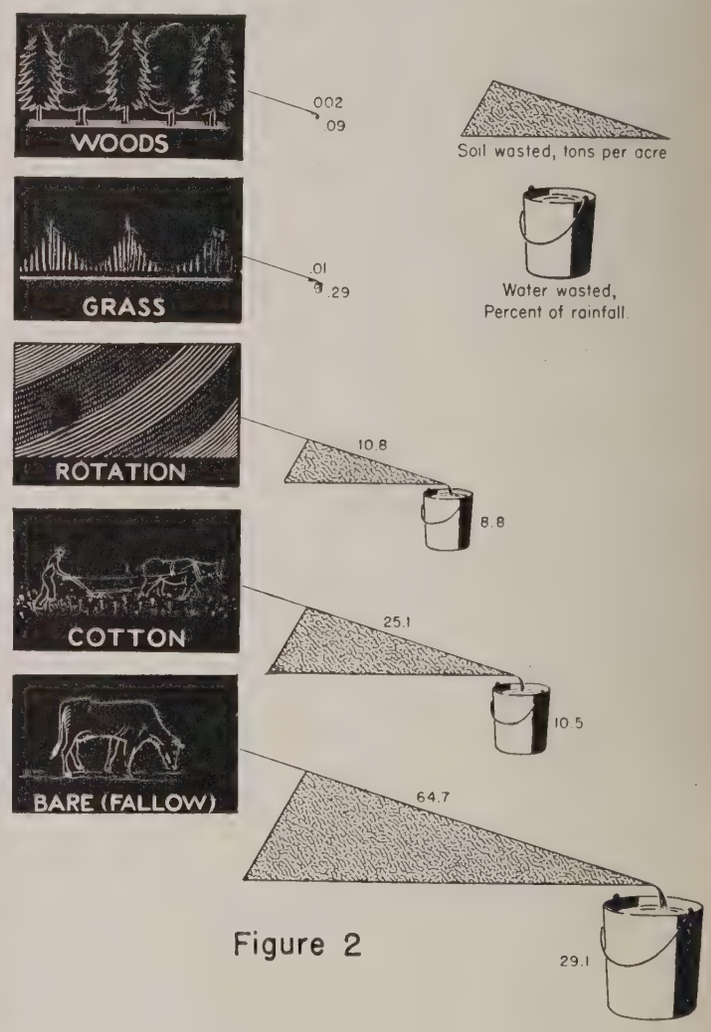


Figure 2

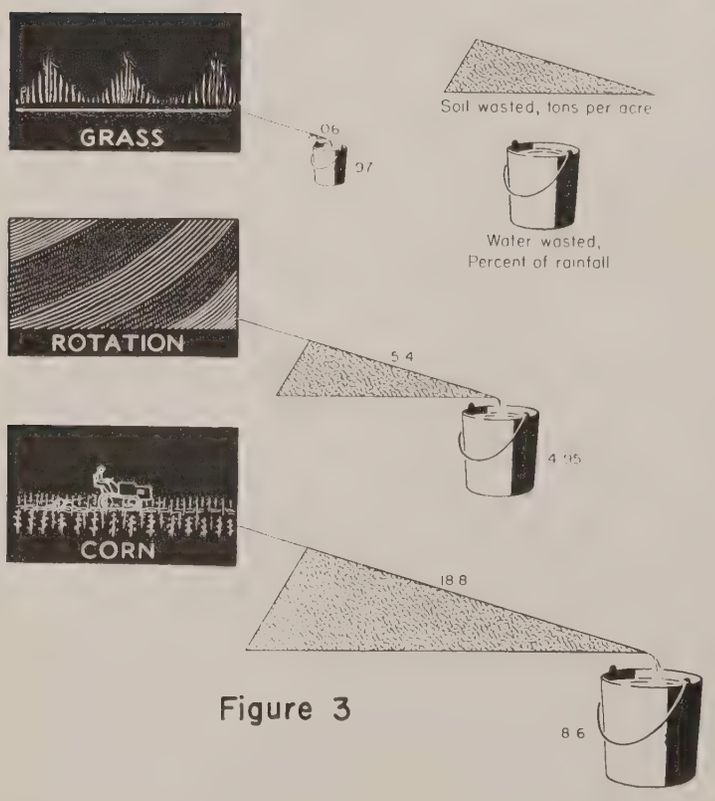


Figure 3

Figure 1

Annual losses of soil and water from same kind of land (Muskingum silt loam, 12-percent slope), with same rainfall, from woods, grass, rotated fields, bare land, corn (S C S station, Zanesville, Ohio, 1934-36

Figure 2

Annual losses of soil and water from same kind of land (Cecil sandy clay loam, 10-percent slope), with same rainfall, from woods, grass, rotated fields, continuous cotton, bare land (S C S station, Statesville, N C., 1932-36)

Figure 3

Annual losses of soil and water from same kind of land (Marshall silt loam, 9.0-percent slope), with same rainfall, from grass, rotated fields, corn (S.C S station, Clarinda, Iowa, 1933-35)

Results, at a Glance. What the experiment stations show.

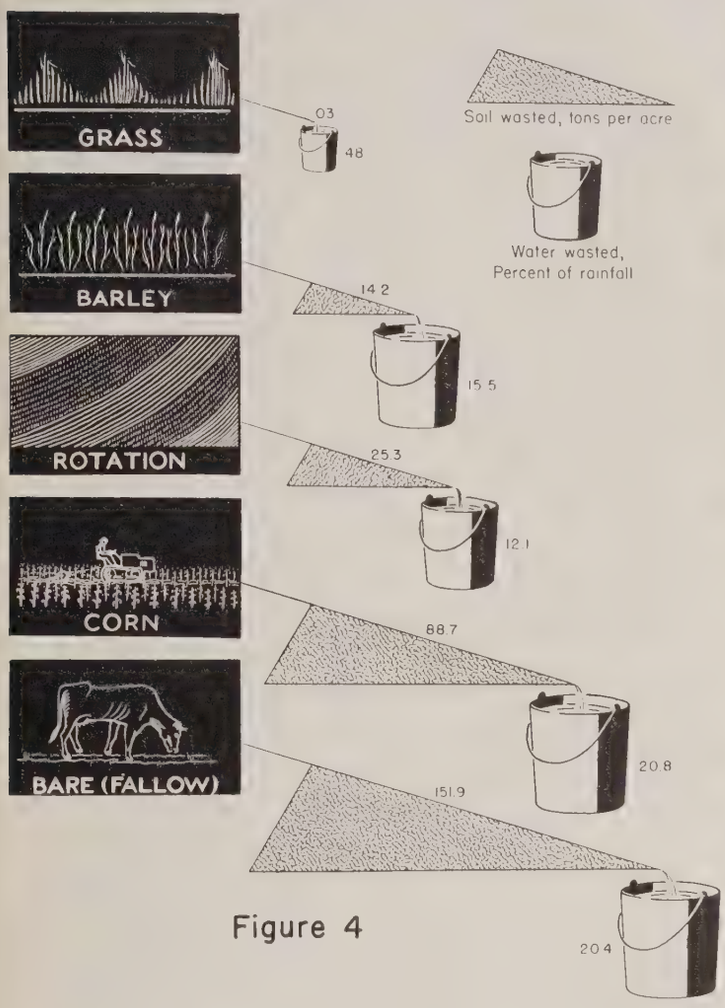
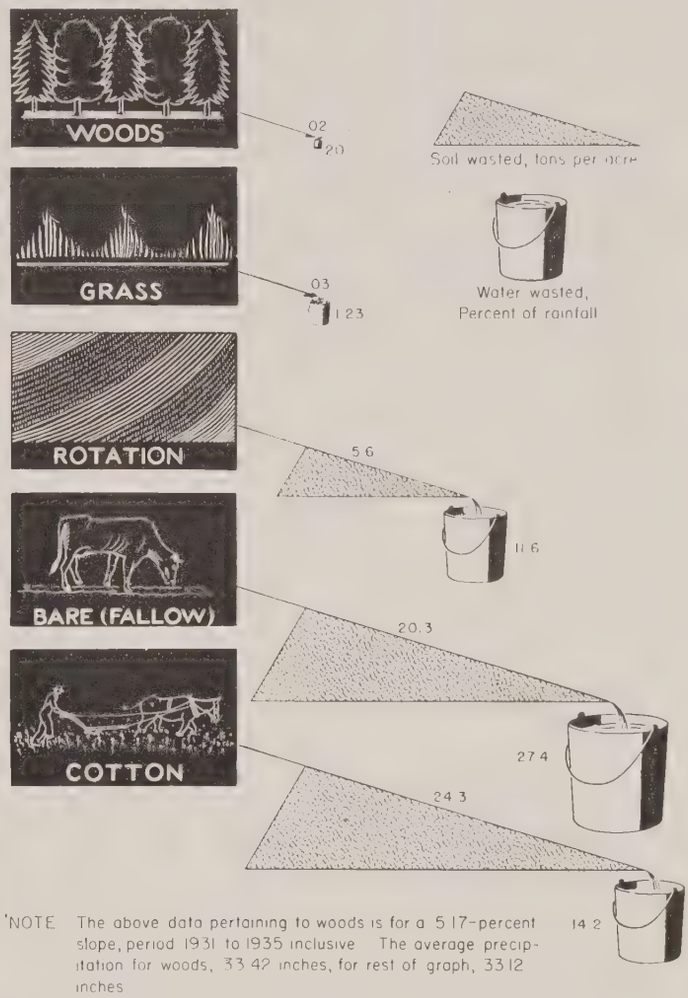


Figure 4



*NOTE The above data pertaining to woods is for a 5.17-percent slope, period 1931 to 1935 inclusive The average precipitation for woods, 33.42 inches, for rest of graph, 33.12 inches

Figure 5

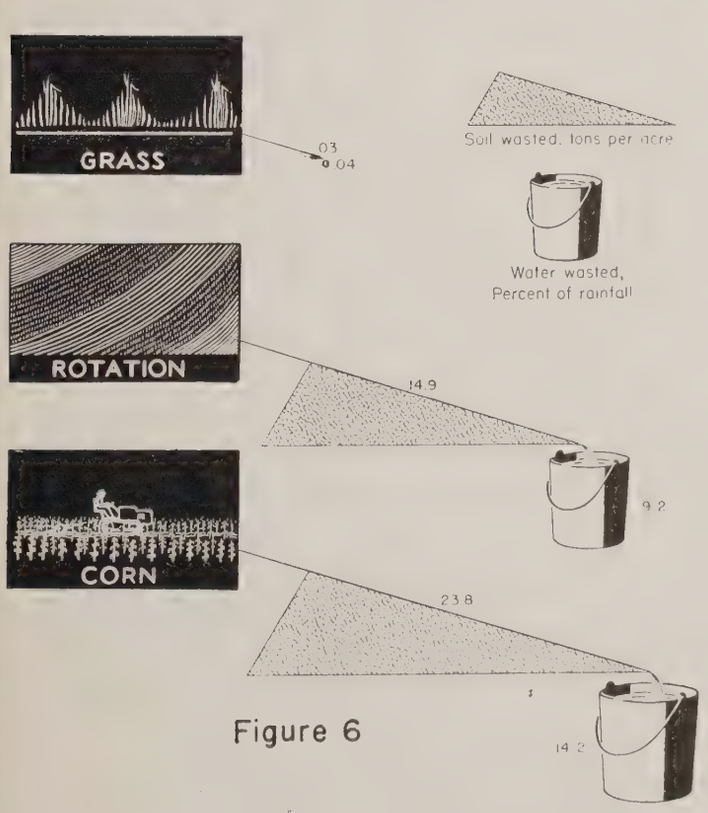


Figure 6

Figure 4

Annual losses of soil and water from same kind of land (Clinton silt loam, 16.0-percent slope), with same rainfall, from: grass, continuous barley, rotated fields, continuous corn, bare land (S. C. S. station, La Crosse, Wis., 1933-35)

Figure 5

Annual losses of soil and water from same kind of land (Vernon fine sandy loam, 7.7-percent slope), from woods, grass, rotated fields, bare land, cotton (S. C. S. station, Guthrie, Okla., 1930-35)

Figure 6

Annual losses of soil and water from same kind of land (Houston black clay, 4-percent slope), with same rainfall, from grass, rotated fields, corn (S. C. S. station, Temple, Texas, 1931-36)

Results, at a Glance. What the experiment stations show.

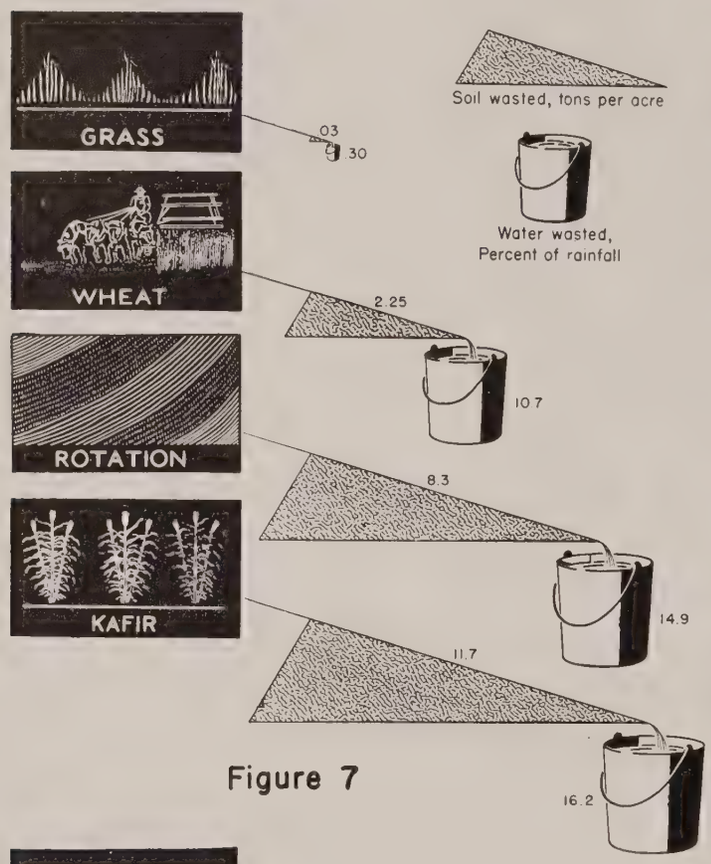
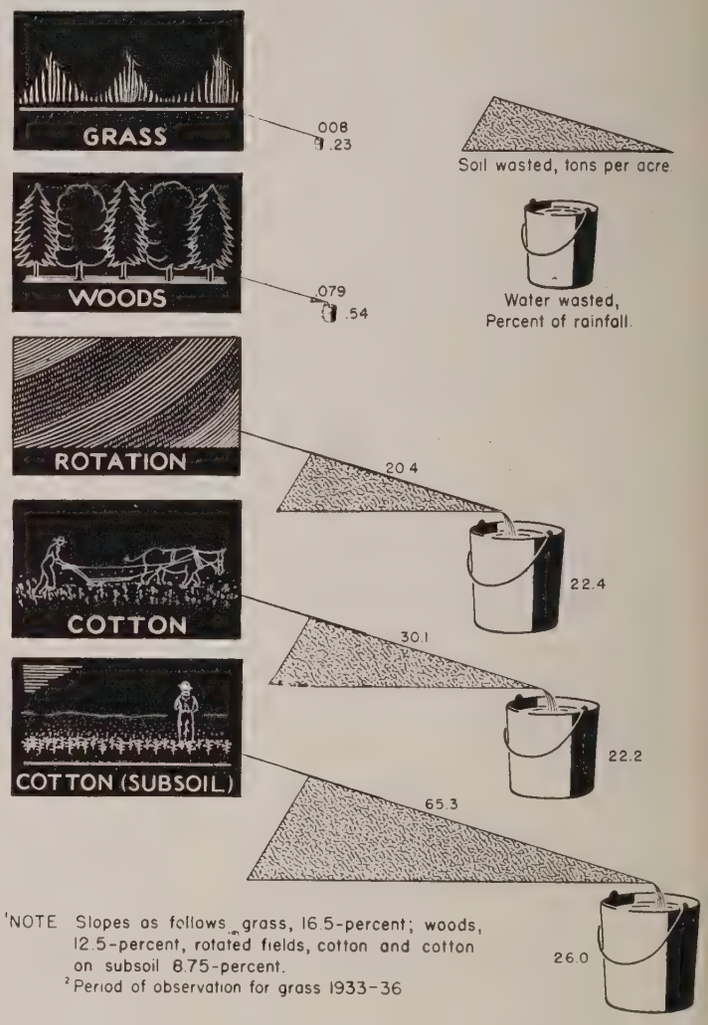


Figure 7



[1]NOTE Slopes as follows grass, 16.5-percent; woods, 12.5-percent, rotated fields, cotton and cotton on subsoil 8.75-percent.
[2]Period of observation for grass 1933–36

Figure 8

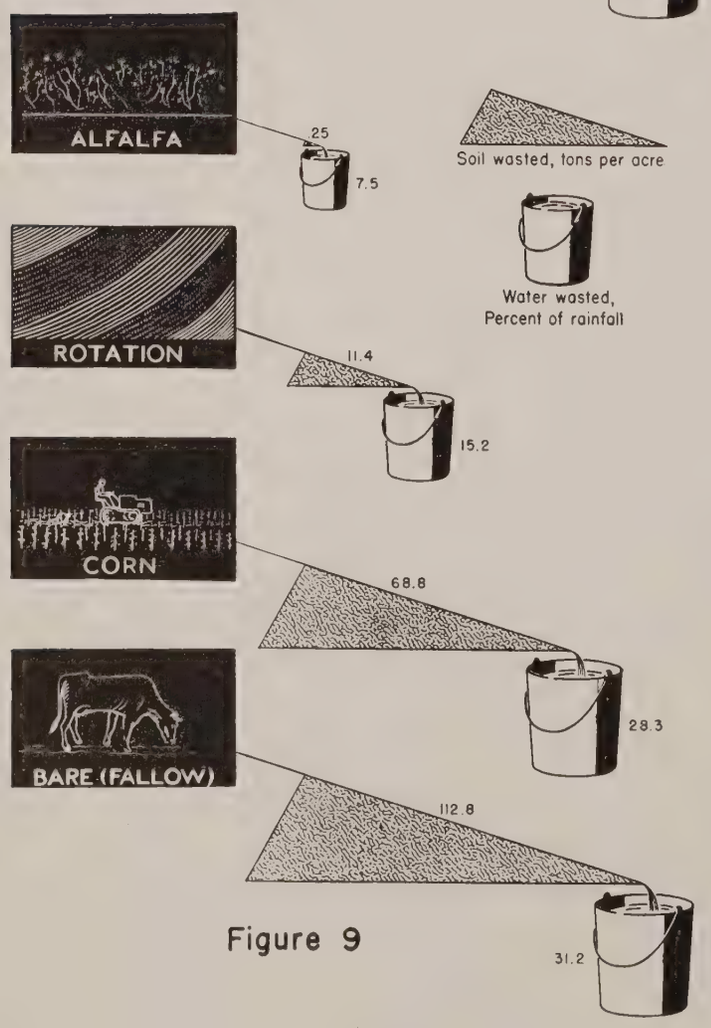


Figure 9

Figure 7

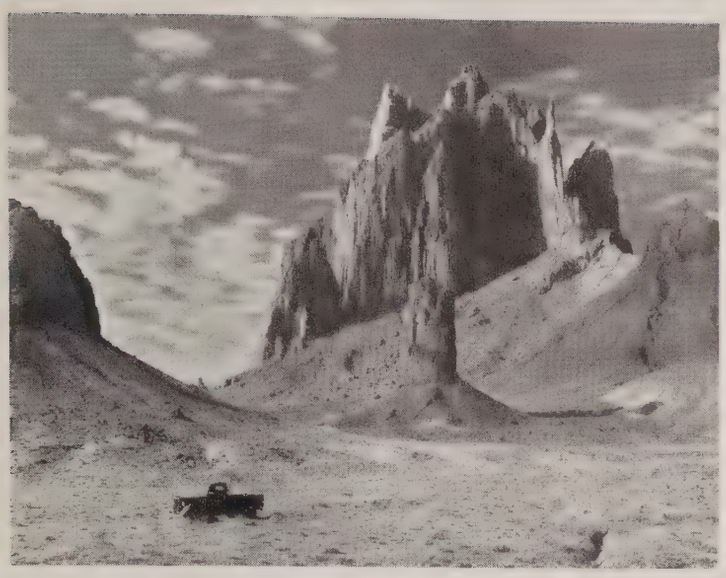
Annual losses of soil and water from same kind of land (Colby silty clay loam, 5.0-percent slope), with same rainfall, from grass, wheat, rotated fields, continuous kafir (S C S station, Hays, Kan., 1930–35)

Figure 8

Annual losses of soil and water from same kind of land (Kirvin fine sandy loam, various slopes[1]), with same rainfall, from grass[2], woods, rotated fields, cotton, cotton on subsoil (S. C S station, Tyler, Texas, 1932–36)

Figure 9

Annual losses of soil and water from same kind of land (Shelby silt loam, 8-percent slope), with same rainfall, from alfalfa, rotated fields, corn, bare land. (S C S station, Bethany, Mo., 1931–35)



Shiprock, N. Mex.—Geological erosion above, accelerated erosion around base.

Sand dunes at Laguna, Valencia County, N. Mex. The accumulation of sand is on the east slope of the ridge; the main dunes may be seen in the background.

An excellent example of contour fencing in the west. This device is of proved advantage in farming for soil conservation.

An old mesquite stump in Arizona, sprouting several years after being cut.

Proper conservation methods on forest, range, and farm lands do much to sustain the clear flow of water in streams and rivers, to benefit wildlife, to protect breeding places of fish and fowl, and to increase recreational opportunities.

Pictures That Tell the Story

By Horold G. Anthony[1]

SEEING is believing. Trite though the expression may be, the truth expressed in those three words makes them worthy of frequent use. This becomes particularly so, when it comes to transmitting ideas and establishing facts pertaining to the Soil Conservation Service program.

It is generally agreed that the best way to get a "picture" of the whole, or a single phase of the program for soil and moisture conservation in any given project, is to visit that area and "see" the program in its actual application. Since such a visit is not always possible, the next best thing is to bring the project to an individual or to a group of individuals by means of pictures.

Those who have worked with methods of expressing and conveying ideas, have had to face one fundamental problem: How to portray the exact meaning. A dictionary will define a word, but its full connotation is compounded of one's experience and imagination.

A well-taken photograph, on the other hand, has no dubious connotation. It is exact. Its meaning cannot vary as it passes an idea from one mind to another.

On the right of this page is a section taken from the film strip, "Erosion Control in the Southeast." On the left is a section of the strip entitled, "Soil Conservation in California." Study these pictures closely. Without regard to the underlines, which are used primarily for the sake of continuity, note that each picture makes a direct, declarative statement. Like a newspaper headline, each picture states its fact with dramatic simplicity. Every reader gets the identical statement, the same fact.

Pictures condense the thought and penetrate to the heart of an idea. Plainly and simply each picture tells its particular story—a story that is readily accepted because it is seen as true.

To get an idea from talk and type, words and figures must be remembered. When you look at a picture you have only to carry away an impression. Facts presented in pictures are easily grasped and easily remembered.

Use of the correct picture for telling the story of soil conservation becomes increasingly important through whatever vehicle may be employed, such as simple photographs, film strips, motion pictures, transparencies and enlargements.

After all "seeing *is* believing."

[1] In Charge, visual information, Soil Conservation Service, Washington D. C.

U. S. F. S. R
LIBRARY
AUG 2 3 1938

SOIL CONSERVATION

Index

VOLUME III

July 1937 to June 1938

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1938

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION—INDEX TO VOLUME III

JULY 1937–JUNE 1938

Page

ABBOT, H. D.: C. C. C. Operations 237–238
Agriculture, post-war, in Czechoslovakia. Guy R. Stewart 104–105
Agronomic briefs. C. R. Enlow 185
Annuals, wide-row plantings. Frank B. Harper 163–164
ANTHONY, HAROLD G.—
  Goforth's Stores Stand Idle—Her Streets Grow Weeds . . 47, 50
  Meadow Outlet Strips 153–154, 170
  Pictures That Tell the Story 294
  Water Spreading at San Angelo. With R. M. Milhollin . 35–37

BAILEY, R. Y.: Heavy Duty Vegetation for Erosion Control . 42, 46
Banks, roadside, stabilization. F. R. Dreibelbis and Helmut Kohnke 38–40, 52
Basin listing to retain snow moisture. V. H. Florell 194–195
Beaver, as an upstream engineer. Paul M. Scheffer 178–181
BECK, VIRGIL S.: Stabilizing the Dust Bowl. With D. A. Dobkins 157–158, 167
BENNETT, H. H.—
  Foreword to Soil Conservation, September 1937 53
  Sunshine and Shadow 30–33
  The Opportunity Broadens 235
Bermuda grass king. Angus McDonald 97–99
BLOOM, MERLE W.: Contour Furrows Constructed Without Loss of Sod 105–106
Book reviews and abstracts. Phoebe O'Neall Faris. Each issue except April and June.
Bottomlands, protecting from erosional debris: a case history. Carl B. Brown 93–96
BRANDT, A. E.—
  Size and Shape of Control Plots for Run-off Studies . . . 209–210
  What We Have Learned About Terrace Spacing at Guthrie, Oklahoma. With G. W. Musgrave 267–269
BRIGGS, C. R.: Straw Farming 169–170
BRINK, WELLINGTON—
  Blotters Instead of Shingles 186–189
BROWN, CARL B.: Protecting Bottomlands From Erosional Debris: A Case History 93–96
Buckbrush, value in checking dams. W. W. Russell and L. H. Kahler 155–156

CAMPBELL, J. PHIL: Associations Lay Groundwork for Legally-Constituted Districts 132–134, 137
Canadian West, control of soil drifting in. A. H. Joel . . . 111
Cedar, new, for erosion control. Charles F. Swingle 75–78
CHAMBERS, T. B.: Engineering Phase 60–63, 70
China, sand rivers of. W. C. Lowdermilk 1–4, 26–27
Civilian Conservation Corps—
  enrollee, aid in northeastern orchards. James A. Seaman . 243
  enrollee and soil conservation. George P. Tyner 239
  operations. H. D. Abbot 237–238
  work, opportunities, viewing by selecting agency. W. Frank Persons 240–241

Page

Civilian Conservation Corps-Soil Conservation Service camp experience acquired in, how to use. Cecil O. Giesler . . 242, 246
Climatic and Physiographic Research, Section of. *See* under Soil Conservation.
CONNAUGHTON, MARK P.: Preliminary Notes on Reservoir Studies in the Great Plains States 232–233
Conservation—
  contrast with erosion 279
  soil. *See* Soil conservation.
Contour—
  balk method, opportunities. B. H. Hendrickson 107
  furrows—
    construction without loss of sod. Merle W. Bloom . 105–106
    620 miles, stabilize Pocatello hillsides. Glenn M. Querna 171–172, 177, 202
    value in erosion control program 288
CRIDER, F. J.: Propagation [of Plants] 68–70
Crop residues. Chart, back cover. December 1937.
Cropping, strip—
  in Ohio, hill country. J. S. Cutler 151–152, 168
  some pointers. Chart, back cover. August 1937.
  value in erosion control program 287
Crops, use in erosion control program, references. Inside back cover. March 1938.
CUTLER, J. S.—
  Ohio Valley Launches Extension Program 34, 50
  Strip Cropping in Hill Country of Ohio 151–152, 168
Cutters, home-made, for sod 261–262
Czechoslovakia, post-war agriculture and soil erosion in. Guy R. Stewart 104–105

DAHL, ARNOLD S.: Rebuilding Pasture Soils 196–199
Dams, checking by buckbrush. W. W. Russell and L. H. Kahler 155–156
DAVIS, ARNOLD: Bringing Erosion Control to Some Highways 48–50
Debris, erosional, protecting bottomlands from, a case history. Carl B. Brown 93–96
Detwiler, S. B.—
  Fifty Years' Experience Gives Japan Simple, Effective [Soil Conservation] Program 9–10
  Slope Usage 64–67, 83–84
  The Soil-Saving Persimmon 230–231
DIENER, H. C.: Farm Planning 82–83
DOBKINS, D. A.: Stabilizing the Dust Bowl. With Virgil S. Beck 157–158, 167
DOBSON, G. C.: Relation of Sedimentation Studies to a Flood-Control Program 219–222, 234
DREIBELBIS, F. R.: Stabilization of Roadside Banks. With Helmut Kohnke 38–40, 52
"Dust bowl"—
  problem, solution in Vermont. C. B. Maits, Jr 146–147
  stabilizing. D. A. Dobkins and Virgil S. Beck . . . 157–158, 167

Page

Easterday, A. M.: Weed Terraces 45–46
Economic implications of a soil and water conservation program. Walter J. Roth and Alexis N. Garin 223–225
Employment selecting agency, view of C. C. C. work opportunities. W. Frank Persons 240–241
Engineer, upstream, example of beaver. Paul M. Scheffer. 178–181
Engineering practices in erosion control, references. Inside, back cover. May 1938.
ENLOW, C. R.: Agronomic Briefs 185
Enrollee. *See* Civilian Conservation Corps enrollee.
Erosion—
  contrast with conservation 279
  control—
    bringing to some highways. Arnold Davis 48–50
    ecological principles. W. C. Lowdermilk 54, 59
    engineering phase. T. B. Chambers 60–63, 70
    heavy duty vegetation for. R. Y. Bailey 42, 46
    in Great Plains, helping by means of windbreaks. George W. Hood 247–249, 254, 257
    introduced plants used in, list 115
    practices in Missouri, withstanding tests that come once in a century. R. H. Musser 43–44, 52
    promising new cedar for. Charles F. Swingle 75–78
    some important introduced plants in. Chart, back cover. July 1937.
    State legislation for. Philip M. Glick 120–125
  debris, protection of bottomlands from, a case history. Carl B. Brown 93–96
  ecological relations. Charles J. Whitfield 262–264, 270
  experiment stations, results of erosion control program .. 290–292
  soil—
    cause and consequence 274–279
    in Czechoslovakia. Guy R. Stewart 104–105
    in Madagascar. Charles F. Swingle 102–104
    problems on irrigated farm land. Dana F. Kirkmire 112–114, 116
  wind, control, research contributions. H. H. Finnell .. 255–257

FARIS, PHOEBE O'NEALL: Book Reviews and Abstracts. Each issue except April and June.
Farm—
  land, irrigated, soil-erosion problems. Dana F. Kirkmire .. 112–114, 116
  old, new life for. Walter V. Kell 79–81, 84
  planning. H. C. Diener 82–83
Farmer, mutual interest with society in land. M. L. Wilson 117–119, 143
FECHNER, ROBERT: Youth and the Land 236
Fences, use in saving soil. Ivy M. Howard 159–160
Fertilizers, use in erosion control program, references. Inside back cover. March 1938.
Film strips, list. Inside, back cover. June 1938.
FINNELL, H. H.: Research Contributions to Wind Erosion Control 255–257
Flood control—
  A. L. Patrick 55–57
  articles in Soil Conservation, volumes 1 and 2, list 114
  program, relation to sedimentation studies. G. C. Dobson 219–222, 234
FLORELL, V. H.: Basin Listing to Retain Snow Moisture 194–195, 200, 202

Page

Forest destruction in Madagascar. Charles F. Swingle .. 102–104
FULGHUM, RALPH: Water Disposal Plan Required .. 148–150, 167
Furrows, contour. *See* Contour furrows.

GAPEN, KENNETH M.: Grass and Water Storage on a Quarter-Million Acre Ranch 161–162, 168, 170
GARIN, ALEXIS N.: Economic Implications of a Soil and Water Conservation Program. With Walter J. Roth. 223–225
GARSTKA, WALTER URBAN: In-Place Lysimeters Near Coshocton, Ohio 91–92
GIESLER, CECIL O.: How I Plan to Use Experience Acquired in an S. C. S.-C. C. C. Camp 242, 246
GLICK, PHILIP M.: State Legislation for Erosion Control. 120–125
Gold in grass roots. Harry E. Reddick 165–167
"Good heart", maintaining English soils in. J. Everard Hosking 5–8, 13, 28
Grass—
  in action. Ivy M. Howard 259–261
  roots, gold in. Harry E. Reddick 165–167
  seed. M. M. Hoover 72, 84
  storage on quarter-million acre ranch. Kenneth M. Gapen 161–162, 168, 170
  value in erosion control 284–286
Grasses, native in Pacific Northwest. Chart, back cover. September 1937.
Great Plains—
  erosion control by means of windbreaks. George W. Hood 247–249, 254, 257
  problems, parallel to those of South Africa. Lois Olson. 18–21
Great Plains States, reservoir stuoies in, preliminary notes. Mark P. Connaughton 232–233
Growth, synthetic, substances for, new development. V. T. Stoutemyer 182–184, 189, 199, 202
Gullies, elimination by erosion control program 276–277

HARPER, FRANK B.: Wide-Row Plantings of Annuals ... 163–164
HENDRICKSON, B. H.: Opportunities for the Contour Balk Method 107
Highways, some, bringing erosion control to. Arnold Davis 48–50
Hillsides, Pocatello, stabilizing by 620 miles of contour furrows. Glenn M. Querna 171–172, 177, 202
Home-made sod cutters 261–262
HOOD, GEORGE W.: Windbreaks Help Control Erosion in the Great Plains 247–249, 254, 257
HOOVER, M. M.: Grass Seed 72, 84
HOSKING, J. EVERARD: Maintaining English Soils in "Good Heart." 5–8, 13, 28
HOWARD, IVY M.—
  Grass in Action 259–261
  Pioneers of Today 244–246
  Soil-Saving Fences 159–160
Humus and soil conservation. Selman A. Waksman ... 250–254
Hydraulics, studies, references. Inside back cover. October 1937.
Hydrologic—
  cycle, re-examination. C. W. Thornthwaite 85–91
  investigations on selected watersheds. C. E. Ramser. 215–219
Hydrology, studies, references. Inside back cover. October 1937.

Page

Irrigation—
of farm land, soil-erosion problems. Dana F. Kirkmire... 112–114, 116
practices in erosion control, references. Inside, back cover. May 1938.

Japan, soil conservation program, simple and effective evolution after fifty years' experience. S. B. Detwiler..... 9–10
JARDINE, JAMES T.: A Challenging Field for Research..... 203
Java, raindrops in, slowing. Guy R. Stewart..... 22–25, 28
JOEL, A. H.: Control of Soil Drifting in Canadian West..... 111
JOHNSON, V. WEBSTER: Rural Zoning Improves Land Use in Wisconsin..... 138–143
JOTTER, E. V.: Trees..... 57–58

KAHLER, L. H.: Buckbrush Check Dams. With W. W. Russell..... 155–156
KELL, WALTER V.: New Life for the Old Farm..... 79–81, 84
KING, BARRINGTON: Vegetation Cuts Costs..... 59
KIRKMIRE, DANA F.: Soil-Erosion Problems on Irrigated Farm [Land..... 112–114, 116
KOHNKE, HELMUT: Stabilization of Roadside Banks. With F. R. Dreibelbis..... 38–40, 52

Land—
and the youth. Robert Fechner..... 236
mutual interests of society and farmer. M. L. Wilson.. 117–119, 143
protection by present erosion control program..... 278
use planning, national, regional, and State, references. Inside back cover. November 1937.
use, rural zoning improvement in Wisconsin. V. Webster Johnson..... 138–143
Legislation, State, for erosion control. Philip M. Glick.. 120–125
Lespedeza, relationships. A. J. Pieters..... 265–266
LOWDERMILK, W. C.—
Ecological Principles..... 54, 59
Research in Soil Conservation..... 204–208
Sand Rivers of China..... 1–4, 26–27
Lysimeters, in-place, near Coshocton, Ohio. Walter Urban Garstka..... 91–92

Machinery, specialized, use in erosion control program.... 289
Madagascar, forest destruction and soil erosion in. Charles F. Swingle..... 102–104
MAITS, C. B., Jr.: Vermont Takes a Cue From the Dust Bowl..... 146–147
McDONALD, ANGUS: The Bermuda Grass King..... 97–99
Meadow—
outlet strips. Harold G. Anthony..... 153–154, 170
strips..... 181
MILHOLLIN, R. M.: Water Spreading at San Angelo, Texas. With Harold G. Anthony..... 35–37
Minnesota, soil conservation projects. Wellingtbn Brink. 186–189
Missouri, erosion control practices, withstanding tests that come once in a century. R. H. Musser..... 43–44, 52
Mixtures, seeding..... 181
Moisture, snow, retaining by basin listing. V. H. Florell. 194–195
Motion pictures—
list. Inside, back cover. June 1938.
use to tell the story. Harold G. Anthony..... 294

Page

MUSGRAVE, G. W.—
Field Research Offers Significant New Findings..... 210–214
What We Have Learned About Terrace Spacing at Guthrie, Oklahoma. With A. E. Brandt..... 267–269
MUSSER, R. H.: Withstanding a Test That Comes Once in a Century..... 43–44, 52
MYER, DILLON S.: [Soil Conservation Legislation] Next Step: Emphasis Shifts to Districts Plan..... 126–131

NEWPORT, FRED C.: The Reclamation of a Sand Dune Area. With Charles J. Whitfield..... 190–193
North Carolina, first district to lead way. I. O. Schaub. 135–136
Northeastern orchards, C. C. C. enrollee aid. James A. Seaman..... 243

Ohio—
Coshocton, in-place lysimeters near. Walter Urban Garstka..... 91–92
strip cropping in hill country. J. S. Cutler..... 151–152, 168
Ohio Valley, extension program, launching. J. S. Cutler.. 34, 50
Oklahoma, Guthrie, terrace spacing, results. A. E. Brandt and G. W. Musgrave..... 267–269
OLSON, LOIS: South African Problems Parallel Those of Great Plains..... 18–21
Orchards, northeastern, C. C. C. enrollee aid. James A. Seaman..... 243

Pacific Northwest, native grasses in. Chart, back cover. September 1937.
Pasture soils, rebuilding. Arnold S. Dahl..... 196–199
PATRICK, AUSTIN L.—
appointment to Soil Conservation Service, Watershed and Conservation Survey Division..... 29
Flood Control..... 55–57
Persimmon trees, use in saving soil. S. B. Detwiler..... 230–231
PERSONS, W. FRANK: A Selecting Agency Views C. C. C. Work Opportunities..... 240–241
PIETERS, A. J.: Some Lespedeza Relationships..... 265–266
Pioneers of today. Ivy M. Howard..... 244–246
Plantings, wide-row, of annuals. Frank B. Harper..... 163–164
Plants—
introduced, important in erosion control. Chart, back cover. July, 1937 except June.
introduced, in erosion control, list..... 115
propagation. F. J. Crider..... 68–70
Plots, control, size and shape for run-off, studies. A. E. Brandt..... 209–210
Pocatello hillsides, stabilizing by 620 miles of contour furrows. Glenn M. Querna..... 171–172, 177, 202
Punjab, coordinated attack, plans for. Guy R. Stewart. 14–17, 21

QUERNA, GLENN M.: 620 Miles of Contour Furrows Stabilize Pocatello Hillsides..... 171–172, 177, 202

Raindrops, slowing, in Java and Sumatra. Guy R. Stewart..... 22–25, 28
RAMSER, C. E.: Hydrologic Investigations on Selected Watersheds..... 215–218
Ranch, quarter-million acre, grass and water storage on. Kenneth M. Gapen..... 161–162, 168, 170
Reclamation, sand dune area. Charles J. Whitfield and Fred C. Newport..... 190–193
REDDICK, HARRY E.: Gold in the Grass Roots..... 165–167

Page

References, compilation. Etta G. Rogers. *See* inside back cover, each issue except June.
Research—
challenging field for. James T. Jardine 203
Chart, back cover. February 1938.
contributions to wind erosion control. H. H. Finnell . . 255–257
field, offers significant new findings. G. W. Musgrave . . 210–214
in soil conservation. W. C. Lowdermilk 204–208
Reservoir studies—
articles in Soil Conservation, volumes 1 and 2, list 114
in Great Plains States, preliminary notes. Mark P. Connaughton 232–233
Ringland, Arthur C.: Sybaris: An Example of Watershed Control in Operation 11–13
Rivers, sand, of China. W. C. Lowdermilk 1–4, 26–27
Roadside banks, stabilization. F. R. Dreibelbis and Helmut Kohnke 38–40, 52
Rogers, Etta G., compilation of references. Inside back cover, each issue except June.
Roth, Walter J.: Economic Implications of a Soil and Water Conservation Program. With Alexis N. Garin . . 223–225
Rows, laying off, "spread row" system. B. L. Taylor 108–111
Run-off, size and shape of control plots, studies. A. E. Brandt 209–210
Rural zoning, improvement of land use in Wisconsin. V. Webster Johnson 138–143
Russell, W. W.: Buckbrush Check Dams. With L. H. Kahler 155–156
Ryegrass, domestic 181

Sand dune area, reclamation. Charles J. Whitfield and Fred C. Newport 190–193
Schaub, I. O.: The First District: North Carolina Leads the Way 135–136
Scheffer, Paul M.: The Beaver as an Upstream Engineer . 178–181
Seaman, James A.: [C. C. C.] Enrollee Aid in Northeastern Orchards 243
Sedimentation studies, relation to flood-control program. G. C. Dobson 219–222, 234
Shadow and sunshine. H. H. Bennett 30–33
Slope usage. S. B. Detwiler 64–67, 83–84
Snow moisture, retaining by basin listing. V. H. Florell . . 194–195
Society, mutual interest with farmer in land. M. L. Wilson . 117–119, 143
Sod cutters, home-made 261–262
Soil—
conservation—
and humus. Selman A. Waksman 250–254
and the C. C. C. enrollee. George P. Tyner 239
associations, groundwork for legally-constituted districts. J. Phil Campbell 132–134, 137
districts, legally-constituted, laying groundwork by associations. J. Phil Campbell 132–134, 137
legislation, next step: Emphasis shifts to districts plan. Dillon S. Myer 126–131
opportunity for the future. H. H. Bennett 235
program, economic implications. Walter J. Roth and Alexis N. Garin 223–225
program, successful, cooperative circle necessary for. Chart, back cover. October 1937.
projects in Minnesota. Wellington Brink 186–189

Page

Soil—Continued.
research. W. C. Lowdermilk 204–208
terrace construction for, adaptation of various types of equipment. Chart, back cover. May 1938.
drifting, control in Canadian West. A. H. Joel 111
erosion. *See* Erosion, soil.
is alive. Chart, back cover. January 1938.
living. Selman A. Waksman 173–177
saving by—
fences. Ivy M. Howard 159–160
use of persimmon trees. S. B. Detwiler 230–231
Soil Conservation, subscription, announcement 70
Soil Conservation Service, Climatic and Physiographic Research, Section of, recent achievements. C. W. Thornthwaite 226–229
Soil Conservation Service-Civilian Conservation Corps Camp, experience acquired in, how to use. Cecil O. Giesler 242, 246
Soils—
English, maintaining in "good heart." J. Everard Hosking 5–8, 13, 28
pasture, rebuilding. Arnold S. Dahl 196–199
South Africa, problems parallel to those of Great Plains. Lois Olson 18–21
"Spread row" system for laying off rows. B. L. Taylor . . . 108–111
Stewart, Guy R.—
Slowing the Raindrops in Java and Sumatra 22–25, 28
The Punjab Plans a Coordinated Attack 14–17, 21
Storage, grass and water on quarter-million acre ranch. Kenneth M. Gapen 161–162, 168, 170
Stores, idle, in Goforth, Texas. Harold G. Anthony 47, 50
Stoutemyer, V. T.: Synthetic Growth Substances, a New Development 182–184, 189, 199, 202
Straw farming. C. R. Briggs 169–170
Strip cropping. *See* Cropping, strip.
Sumatra, raindrops in, slowing. Guy R. Stewart 22–25, 28
Sunshine and shadow. H. H. Bennett 30–33
Swingle, Charles F.—
Forest Destruction and Soil Erosion in Madagascar 102–104
A Promising New Cedar for Erosion Control 75–78
Sybaris: example of watershed control in operation. Arthur C. Ringland 11–13
Synthetic growth substances, a new development. V. T. Stoutemyer 182–184, 189, 199, 202

Taylor, B. L.: The "Spread Row" System for Laying Off Rows 108–111
Terrace—
construction for soil conservation. Chart, back cover. May 1938.
outlets 181
spacing, results at Guthrie, Oklahoma. A. E. Brandt and G. W. Musgrave 267–269
Terraces—
value in erosion control program 288
weed. A. M. Easterday 45–46
Texas—
Goforth, stores standing idle, and weeds growing in streets. Harold G. Anthony 47, 50
San Angelo, water spreading. R. M. Milhollin and Harold G. Anthony 35–37

THORNTHWAITE, C. W.— Page
Recent Achievements of the Section of Climatic and Physiographic Research 226–229
The Hydrologic Cycle Re-Examined 85–91
Today's pioneers. Ivy M. Howard 244–246
Trees—
E. V. Jotter 57–58
part in erosion control 280–283
TYNER, GEORGE P.: The [C. C. C.] Enrollee and Soil Conservation 239

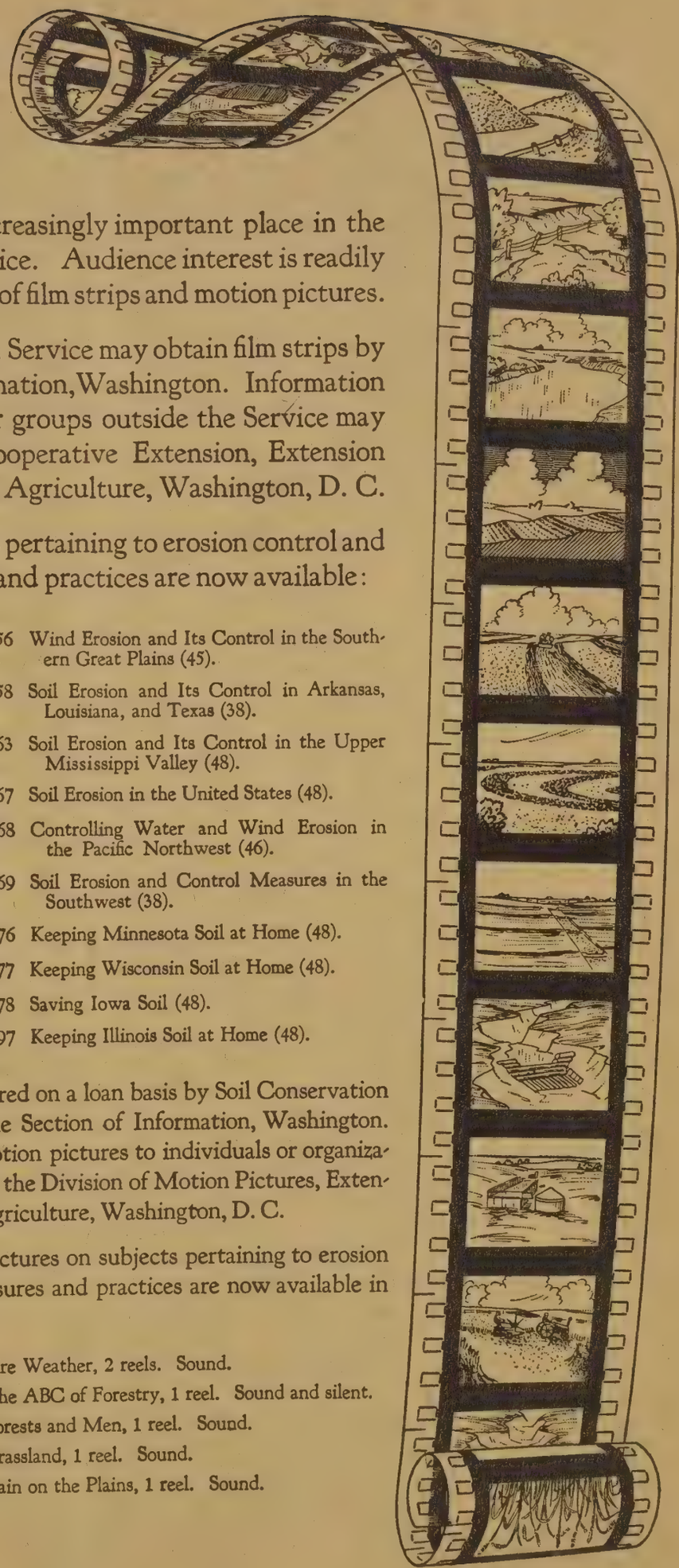
VAN DERSAL, WILLIAM R.—
A Border for the Woods 99–101
Wildlife Management 73–75
Vegetation—
cuts costs. Barrington King 59
ecological relations. Charles J. Whitfield 262–264, 270
heavy duty, for erosion control. R. Y. Bailey 42, 46
use in mechanical erosion-control structures. T. B. Chambers 60–63, 70
used in erosion control, references. Inside back cover. September 1937.
Vermont, use of methods from "dust bowl" region. C. B. Maits, Jr 146–147

WAKSMAN, SELMAN A.—
Humus and Soil Conservation 250–254
The Living Soil 173–177
Water—
conservation—
program, economic implications. Walter J. Roth and Alexis N. Garin 223–225

Water—Continued. Page
conservation—Continued.
studies. Inside back cover. October 1937.
disposal plan required. Ralph Fulghum 148–150, 167
spreading at San Angelo, Texas. R. M. Milhollin and Harold G. Anthony 35–37
storage, on quarter-million acre ranch. Kenneth M. Gapen 161–162, 168, 170
Watershed and Conservation Survey Division, creation, announcement 29
Watershed control, in operation, Sybaris as an example. Arthur C. Ringland 11–13
Watersheds, selected, hydrologic investigations. C. E. Ramser 215–218
Weed terraces. A. M. Easterday 45–46
Weeds, growing in streets of Goforth, Texas. Harold G. Anthony 47, 50
WHITFIELD, CHARLES J.: Ecological Relations of Vegetation and Erosion 262–264, 270
The Reclamation of a Sand Dune Area. With Fred C. Newport 190–193
Wildlife management. William R. Van Dersal 73–75
WILSON, M. L.: Society and the Farmer Have Mutual Interests in the Land 117–119, 143
Wind erosion. *See* Erosion, wind.
Windbreaks, aid in control of erosion in Great Plains. George W. Hood 247–249, 254, 257
Wisconsin, land use, improvement by rural zoning. V. Webster Johnson 138–143
Woods, border for. William R. Van Dersal 99–101

Youth and the land. Robert Fechner 236

Film Strips and Motion Pictures



Visual information is finding an increasingly important place in the program of the Soil Conservation Service. Audience interest is readily built up and held through the vehicles of film strips and motion pictures.

Field offices of the Soil Conservation Service may obtain film strips by ordering through the Section of Information, Washington. Information regarding film strips by individuals or groups outside the Service may be secured from the Division of Cooperative Extension, Extension Service, United States Department of Agriculture, Washington, D. C.

The following film strips on subjects pertaining to erosion control and soil and water conservation measures and practices are now available:

244 Soil Erosion, A National Menace (95).[1]

318 Gully Control and Terracing Experiments, Erosion Experiment Farms (47).

419 Soil Erosion and Its Control in the Ohio Valley (40).

421 Soil Erosion Problems and Control Methods in California (43).

425 Erosion Control on the Northern Great Plains (43).

426 Erosion Control in the North Atlantic States (36).

435 Tillage to Control Wind Erosion (48).

438 Contour Furrows (32).

439 Strip Cropping (35).

442 Farming Practices that Conserve Soil and Water (48).

455 Control of Water Erosion in the Central Great Plains (48).

456 Wind Erosion and Its Control in the Southern Great Plains (45).

458 Soil Erosion and Its Control in Arkansas, Louisiana, and Texas (38).

463 Soil Erosion and Its Control in the Upper Mississippi Valley (48).

467 Soil Erosion in the United States (48).

468 Controlling Water and Wind Erosion in the Pacific Northwest (46).

469 Soil Erosion and Control Measures in the Southwest (38).

476 Keeping Minnesota Soil at Home (48).

477 Keeping Wisconsin Soil at Home (48).

478 Saving Iowa Soil (48).

497 Keeping Illinois Soil at Home (48).

Motion pictures may be purchased or secured on a loan basis by Soil Conservation Service field offices by ordering through the Section of Information, Washington. Information regarding purchase or loan of motion pictures to individuals or organizations outside the Service may be secured from the Division of Motion Pictures, Extension Service, United States Department of Agriculture, Washington, D. C.

The following selected group of motion pictures on subjects pertaining to erosion control and soil and water conservation measures and practices are now available in 35- and 16-millimeter sizes:

CCC Fights Erosion, 1 reel. Sound.

Chapparal, 2 reels. Silent.

Muddy Waters, 1 reel. Sound.

Forest Fires or Game? 1 reel. Sound and silent.

Stop Forest Fires, 1 reel. Sound.

Forest and Health, 1 reel. Sound and silent.

Fire Weather, 2 reels. Sound.

The ABC of Forestry, 1 reel. Sound and silent.

Forests and Men, 1 reel. Sound.

Grassland, 1 reel. Sound.

Rain on the Plains, 1 reel. Sound.

---

[1]Number of frames.